ERTS EXPERIMENTS

compiled by

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This collection of summaries of ERTS experiments was compiled by asking each Principal Investigator to prepare the entry for his own experiment. Because of time constraints it was not possible to obtain summaries of all experiments, however, we endeavoured to insure that all major programs in the continental United States were included. The summaries were then grouped according to discipline and arranged in alphabetical order. The disciplines are:

I. AGRICULTURE/FORESTRY
II. ENVIRONMENTAL QUALITY/ECOLOGY
III. CARTOGRAPHY/GEOGRAPHY/DEMOGRAPHY
IV. GEOLOGY
V. HYDROLOGY/WATER RESOURCES
VI. INTERPRETIVE TECHNIQUES DEVELOPMENT
VII. METEOROLOGY
VIII. OCEANOGRAPHY
IX. SENSOR TECHNOLOGY

Since many of these experiments are truly interdisciplinary, the discipline assignment is in some cases arbitrary. The titles and names of principal investigators for experiments for which no summary was available were grouped with their apparent discipline.

The list of experiments was provided by the National Aeronautics and Space Administration (NASA) and included all approved ERTS projects as of July 1972. Release of this list by NASA was for information purposes only and in no way implies official endorsement of this Special Issue. Since ERTS is a dynamic program experiments were added and deleted after the closing date for this issue.

We acknowledge the aid of the numerous principal investigators who prepared the summaries and who we think have contributed towards making this issue a valuable research source.

## I. AGRICULTURE/FORESTRY

TITLE: EVALUATION AND COMPARISON OF ERTS MEASUREMENTS OF MAJOR CROPS AND SOIL ASSOCIATIONS FOR SELECTED SITES IN THE CENTRAL UNITED STATES (UN630; MMC#050)

PRINCIPAL INVESTIGATOR:

Dr. Marion F. Baumgardner
Laboratory for Applications of Remote Sensing
Purdue University
W. Lafayette, Indiana 47907

SUMMARY. The objective of this experiment is to evaluate the utility of ERTS-1 measurements for use in identifying, locating, characterizing and mapping differences in soils and vegetation over a wide range of climatic, geographical, and ecological conditions. Six test sites were selected within the latitudinal range from 32°30'N to 48°00'N and longitudinal range from 86°10'W to 102°40'W. Both non-supervised and supervised computer classification programs will be used in the analysis of MSS digital data. The experiment is designed to test the feasibility and applicability of these techniques in (1) identification and delineation of soil orders, great soil groups and soil associations; (2) seasonal and geographical changes in spectral characteristics of soils and vegetation; (3) spectral characterization of the conditions of natural vegetation and cultivated crops under normal and stress conditions. One of the anticipated benefits of this experiment is the development of methodology for comparison of spectral responses from similar soils and vegetative cover anywhere in the world.

TITLE: WETLANDS MAPPING AND MONITORING WITH ERTS

PRINCIPAL INVESTIGATOR:

Dr. Richard R. Anderson
American University
Dept. of Biology, Hurst Hall
Washington, D.C. 20016

TITLE: TIMBER INVENTORY - LAND USE IN HUELUA, SPAIN

PRINCIPAL INVESTIGATOR:

Dr. Emilio De Benito
Univ. Politecnica De Madrid
Ciudád Universitaria
Madrid 3, Spain

TITLE: INVESTIGATION OF SEASONAL CHANGES IN THE RANGELANDS OF BOTSWANA, PARTICULARLY THE WESTERN KWENENG DISTRICT.

PRINCIPAL INVESTIGATOR:
R.H. BENNISON
AGRICULTURAL RESEARCH STATION
PRIVATE BAG 33
GABORONE, BOTSWANA.

SUMMARY: Ranching and Cattle grazing have always been the mainstay of Botswana's economy. In order to improve and develop agricultural methods, it is necessary to build an accurate vegetation map of the country. ERTS photography will be used in conjunction with existing ground surveys and aerial photography to achieve this, to identify areas suitable for development and those areas where counter measures are needed to combat erosion and degradation of the land. Particular importance is attached to the Western Kweneng district, Central Southern Botswana, where intensive conventional studies are in progress.

TITLE: PREDICT EPHEMERAL AND PERENNIAL RANGE QUANTITY AND QUALITY DURING NORMAL GRAZING SEASON (MMC # 147)

PRINCIPAL INVESTIGATOR:

Mr. Gordon Bentley
Bureau of Land Management
Box 723
Riverside, California 92502

SUMMARY: This experiment will test application of satellite and high flight imagery to several resource management problems confronting the Bureau of Land Management (BLM). Livestock forage in deserts of the southwest is based upon ephemeral plants highly reactive to variable amounts of precipitation. A fast, effective tool for determining forage production over large complex areas is needed. Livestock grazing perennial plants on rangelands throughout the west are being managed under sophisticated grazing formulas. A tool is needed to evaluate effects of grazing rotation. Vegetation of Alaska is virtually unmapped. A means of delineating broad classes of vegetation is needed. The composite representation of color infrared from ERTS data will be used to delineate vegetation differences due to climate, grazing, etc. using visual techniques. Multispectral data from ERTS sensors will be subjected to a density slicing process to determine the usefulness of more sophisticated analysis procedures. Positive results of this study could greatly improve the data gathering and analysis capability of BLM.

TITLE: STUDY APPLICATION OF REMOTE SENSING DATA TO AGRICULTURAL PRACTICES IN THE MISSISSIPPI DELTA

PRINCIPAL INVESTIGATOR:

C.W. Bouchillon
Mississippi State University
P.O. Drawer GH
State College, Miss. 39762

TITLE: IDENTIFICATION OF PHENOLOGICAL STAGES AND VEGETATIVE TYPES FOR LAND USE CLASSIFICATION IN WILDERNESS AREAS SUBJECT TO IMMINENT DEVELOPMENT

PRINCIPAL INVESTIGATOR:

C. Ivan Branton
Institute of Agricultural Sciences
University of Alaska
Palmer, Alaska 99645

SUMMARY: This experiment is planned to explore the suitability of data from satellite mounted sensors for use in the identification of vegetative communities and the phenological stage of these associations. Natural vegetation is being used as an indicator of soil conditions and site limitations. On site observations plus low and medium height aerial photography is being utilized for a detailed study of six plots within the test area. All are located along a N-S line between the 149° and 151° W. Meridians. Detailed resource information from conventional photography will be compared to satellite imagery and spectral patterns obtained from it with a color additive projector viewer. A computer program developed under a cooperative project will be used to develop maps from significant spectral patterns observed using ERTS-A-MSS sensor. It is anticipated that ERTS imagery will facilitate classification and land use planning in wilderness Alaska.

TITLE: SOIL SURVEY, CROP INVENTORY, SOIL MOISTURE AND SALINITY STUDIES

PRINCIPAL INVESTIGATOR:

Dr. T. De Meester
Lab of Soil Science
Agriculture University
Duivendaal 10
Wageningen, The Netherlands

TITLE: PHENOLOGY SATELLITE EXPERIMENT

PRINCIPAL INVESTIGATOR:

Dr. B. E. Dethier
Division of Atmospheric Sciences
Cornell University
Ithaca, New York 14850

SUMMARY: The general objective of this experiment is to develop techniques for identifying phenological changes and plant types on a broad scale as an aid to yield realization and crop management. Foliage development (Green Wave) and vegetation senescence (Brown Wave) are the two phenological stages being observed as a function of time. The 24 primary test sites are located in four corridors: The Appalachian Mountain, Mississippi Valley, Rocky Mountain and Columbia Valley. The natural vegetation being used as a phenological indication in the first two corridors is oak and northern hardwoods. Prairie grassland is the indicator being utilized in the two western corridors. ERTS-I MSS data will be used to obtain spectral signatures characterizing the "green and brown wave". RBV data will also be used to obtain a time-lapse picture of the advance of the "Waves". Ground observations are being taken at six to nine-day intervals along with detailed weather observations. These data will be used with observations from existing phenological networks in an effort to identify phenological events and assess their usefulness as predictors for crop and forest management procedures. This is a coordinated study by members of two agricultural research committees and utilizes the personnel and facilities of 18 State Agricultural Experiment Stations.

TITLE: AGRICULTURAL-LIVESTOCK STUDIES

PRINCIPAL INVESTIGATOR:

Dr. Oscar Dominguez
Inta-Instituto Nacional De
Technologia Agropecuaria
Chile 460
Buenos Aires, Argentina

TITLE: EVALUATION OF ERTS-A IMAGERY IN MAPPING AND MANAGING SOIL AND RANGE RESOURCES IN THE SAND HILLS REGION OF NEBRASKA (MCC #020)

PRINCIPAL INVESTIGATOR:

Dr. James V. Drew
Department of Agronomy
University of Nebraska
Lincoln, Nebraska 68503

SUMMARY: This study involves an interpretation of soil mapping units and range condition classes within the Sand Hills Region of Nebraska utilizing sequential MSS imagery obtained from ERTS-A. Characteristic and repetitive relationships among near-surface hydrology, soils and vegetation within this region provide a unique potential for the successful study of soil and range resources with remote sensing techniques. Since eolian sand is the primary geological material within the 20,000 square miles composing the Sand Hills, soil and vegetation patterns result mainly from differences in topography and hydrology and are not complicated by gross lateral changes in the lithology of surface sediments. Mappable areas of Typic Ustipsamments, Entic Haplustolls, Aquic Haplustolls, Typic Haplaquolls and associated range sites often occupy several hundred acres to several square miles. The basic hypothesis to be tested is that topographic features and the phenology and physiology of plants composing the vegetation will allow interpretation of soil areas, range sites, range condition and degree of forage utilization from reflectance recorded in MSS imagery from ERTS-A. If this hypothesis is correct, it will be possible to use satellite data in managing extensive areas of rangeland in the Sand Hills Region.

TITLE: PROPOSAL TO USE ERTS DATA FOR A MULTIDISCIPLINARY ANALYSIS OF MICHIGAN RESOURCES; TASK II -- EVALUATION OF AGRICULTURAL CROPS

PRINCIPAL INVESTIGATOR:

Dr. A. H. Ellingboe
Professor
Department of Botany and Plant Pathology
Michigan State University
East Lansing, Michigan

SUMMARY: This experiment is designed to determine the potential usefulness of remote sensing from satellites for estimating the agricultural resources of Michigan. The specific objectives include: 1. the verification that major agricultural crops can be identified by M.S.S. techniques from satellites, 2. a determination of how much updating of signatures is required from one fly-over to the next to positively identify a crop, 3. to develop, apply and test the accuracy of M.S.S. techniques for crops acreage estimation from satellites, 4. the correlation of variations in M.S.S signatures from space with ground truth data on factors that offset yield, 5. the procurement of information for studies of the economy of operational spaceborne crop acreage estimation application. The test area includes most of Southern Lower Michigan. Several intensive

study sites have been selected within this large test area. This project is cooperative between Michigan State University; The University of Michigan, Willow Run Laboratories; and the Agricultural Stablization and Conservation Service, U. S. D. A. Extensive ground observations of the test areas have been made with particular reference to conditions that affect crop signatures.

**TITLE:** **USE OF ERTS-A DATA FOR FAO INTEGRATED RESOURCE SURVEY (SR-9603)**

**PRINCIPAL INVESTIGATOR:**

**Dr. O.E. Fischnich**
**Assistant Director-General**
**Agroculture Department**
**FAO, Rome, Italy**

**SUMMARY:** **Various Divisions of the Food and Agriculture Organization of the United Nations, Rome are interested in using the imagery from ERTS-1 for their on-going projects or projects which will come in operation during 1973. Data from these projects will provide the ground-truth information for comparison. It is expected that the results of this experiment will provide an indication of the usefulness of ERTS-1 data for performing integrated resource surveys in developing countries. If the anticipated success is realized, the production of 1/250,000 scale resource maps of large areas of the countries selected will be possible. Such information would have a great impact on the development planning procedures in these countries. Therefore, FAO proposes to assess the usefulness of space imagery for integrated resource survey. The space imagery will be used to supplement existing coverage. The test will be carried out by field staff (in collaboration with the Headquarters' staff) in various projects in Sudan, Colombia and the Philippines. The fields of activities involved are pasture lands, location of desert locust breeding spots and tracing locust migration, and land, water and forestry resources.**

TITLE: USE OF EARTH RESOURCES TECHNOLOGICAL SATELLITE (ERTS) DATA IN A NATURAL RESOURCE INVENTORY

PRINCIPAL INVESTIGATOR:

Ernest B. Fish
Watershed Management Department
College of Agriculture
University of Arizona
Tucson, Arizona 85721

SUMMARY: This research is concerned with developing ground truth and image class grouping criteria for the definition of site-vegetation units as a basis for natural resource inventory and monitoring using remote sensing techniques. A classification system of related ecological units will be developed on different hierarchical levels consistent with natural groupings and compatible with the amount of detail observable and/or interpretable from the imagery. Ground truth data being acquired includes vegetation characteristics, (dominence, cover, structural features), soil characteristics, and physiographic characteristics of each distinguishable image unit.

TITLE: WIND EROSION OF SOILS

PRINCIPAL INVESTIGATOR:

MR. D. W. FRYREAR
USDA, BIG SPRING FIELD STATION
P. O. BOX 909
BIG SPRING, TEXAS 79720

SUMMARY: The aerial extent and the spread of wind eroded soils in the Texas Southern High Plains will be evaluated using ERTS-1 data. Soil cover and soil color characteristics from ground truth data will be related to ERTS imagery. The results will be used to more accurately and timely evaluate the wind erosion status of the test site.

TITLE: IDENT. AND QUANTIFICATION OF CROPS, DYNAMICS OF LAND USE AND AGRICULTURE CENSUS

PRINCIPAL INVESTIGATOR:

Humberto C. Garuti
Direccion Nacional De Economia
Y Sociologia Rural
Paseo Colon 974-3 Piso-of:143
Buenos Aires-Argentina

TITLE: EVAULATION OF THE POTENTIALS OF THE ERTS TECHNIQUES FOR SOIL SURVEY AND CROP INVENTORY AS FOLLOW-UP OF AND IN CONJUNCTION WITH A LONG-TERM AERIAL SURVEY PROJECT

PRINCIPAL INVESTIGATOR:

Dr. Ir. D. Goosen
International Institute for Aerial
Survey and Earth Sciences (ITC)
ENSCHEDE - The Netherlands

SUMMARY: The site for the experiment is the Province of Badajoz, Spain. For the past 6 years the

ITC, in collaboration with the Spanish Authorities, has prepared soil maps of about 1,000 sq. km within the site area. Apart from the panchromatic aerial photographs of 1956, new photography (panchromatic, infrared, normal- and false-color) of a selected area has been used since 1970 for the research on the correlation between soil surface colors and gray (resp. color) tones on these film types.
Crop inventories within the test-area have started in 1971.
The objectives of the experiment are two-fold:
a) Scientific/technical; b) educational.
a) The great variety in parent material of the soils gives rise to many different soil surface colors in the area. It is intended to obtain experience in the handling of small-scale data, with the aim to design a routine in processing the imagery and tapes as a useful tool in survey and crop inventory.
b) To incorporate ERTS images and other data in the soil survey course of the Institute, in the practical fieldwork and in the advanced courses' applied research.

TITLE: DETECTION & MONITORING FOREST INSECT INFESTATIONS IN THE SIERRA NEVADA MOUNTAINS IN CALIFORNIA (MMC # 027)

PRINCIPAL INVESTIGATOR:

Dr. Ralph C. Hall
Natural Resources Management Corporation
Research & Development Division
2150 Shattuck Ave., Berkeley, CA 94704

SUMMARY: The purpose of this experiment is to determine the feasibility and develop methods of early detection and evaluation of forest insect infestations through the use of ERTS imagery. To determine the extent to which space-acquired data alone can be used to successfully detect forest insect infestations and evaluate morbitity in terms of: minimum size of detectable infestation, in acres; intensity of infestation, expressed in general classes (none, light, medium or heavy); stage of infestation (incipient, active, old); kind of insect & nature of damage (defoliation, bark beetle, etc.); to determine the extent to which accuracy of detection can be improved by the concurrent use of high-altitude aerial photography and ERTS imagery through multi-stage sampling procedures; to determine the accuracy with which different kinds of insect infestations can be differentiated from one another and from areas which have been subjected to fires or logging; to compare the effectiveness of color and color IR in detection; and to compare the effect of the season of the year on detectability. The long term objectives are to develop space data acquisition methodology which will eliminate the present need for expensive, patchwork aerial and ground surveys; to provide a continuously up-date basis for operational programs of investigation, control, and salvage; and to permit frequent evaluation of the economic and ecological impact of existing and impending infestations as a basis for determining broad research and control strategies.

TITLE: INVENTORY OF FOREST AND RANGELAND AND DETECTION OF FOREST STRESS (MMC # 226)

PRINCIPAL INVESTIGATOR:

Mr. Robert C. Heller
U. S. Forest Service
Pacific Southwest Forest and Range
Experiment Station
P. O. Box 245
Berkeley, California 94701

SUMMARY: As indicated in the title, there are three disciplines being investigated. One is the identification of forest and land use types near the Atlanta, Georgia, area. In this study we hope to be able to identify changes in forest boundaries and to identify 13 major land use types associated with the national Forest Survey. The second site, in the Black Hills of South Dakota, is experiencing a serious pine bark beetle epidemic. Pine trees are killed singly and in blocks of up to 1,000 trees; the dying trees change from a normal green color to bright yellow and offer resolution targets of varying sizes. We hope to discover whether these discolored patches can be detected from satellite altitudes. Also, we have installed three DCP's at this site to monitor 80 separate biophysical phenomena. Finally, at our rangeland site near Colorado Springs, Colorado, we are monitoring rangelands and identifying the type and productivity and also the infringements summer recreational homesites are making into the forest and rangeland biome. All satellite and underflight aircraft imagery will be examined in five different ways: (1) by human interpretation, (2) by optical combining, (3) by microdensitometric analysis, (4) by computer analysis, and (5) by the combination of analog and digital processing--such as SPARC.

TITLE: AGRICULTURE AND WATER RESOURCE DEVELOPMENT

PRINCIPAL INVESTIGATOR:

Dr. Anwar Hossain
Planning Commission
Dacca, Bangladesh

TITLE: GEO-BOTANICAL SURVEYS; WOODLAND AND FOREST VEGETATION

PRINCIPAL INVESTIGATOR:

Dr. John A. Howard
University of Melbourne
Parkville, Victoria
Australia

TITLE: STUDY OF THE APPLICATION OF ERTS-A DATA TO: AGRICULTURE AND FORESTRY-MISSISSIPPI DELTA ALLUVIAL PLAINS REGION

PRINCIPAL INVESTIGATOR:

Dr. Frank M. Ingels
Department of Electrical Engineering
Mississippi State University
Mississippi State,
Mississippi 39762

SUMMARY: This project is a study and evaluation of ERTS-A remote sensing capabilities with regards to agronomy, grasslands, and forestry. The area to be studied is in the Mississippi Delta region located near the Delta Branch Experiment Station at Stoneville, MS. Test plots containing at least 50 acres of grassland, hardwood timber, or various type crops will be utilized in achieving proper MSS signature analysis. The country level ASCS will cooperate in obtaining necessary ground truth data about these test plots. From this information NASA-MTF-ERL will construct plots showing hardwood forests; weed infested acres; crops, their type, size, and estimated yield; and any other significant outputs which can be derived from ERTS-A MSS data. The MSU research team will identify and locate possible intermediate and low level users of this information. Efforts will then be directed toward deriving a format for this information which is optimized with respect to user interests, and acquainting possible users with the capabilities of remote sended data. The result of the project will be an objective evaluation made in cooperation with sample users of significant applications of ERTS-A data.

TITLE: WHEAT: ITS WATER USE, PRODUCTION AND DISEASE DETECTION AND PREDICTION

PRINCIPAL INVESTIGATOR:

Dr. E. T. Kanemasu
Evapotranspiration Laboratory
Kansas State University
Manhattan, Kansas 66506

SUMMARY: Objectives of the investigation are: (1) to evaluate the effect of water stress, disease and leaf area on the reflectance characteristics of wheat, (2) to evaluate disease losses in terms of yield and water use, and (3) to predict disease severity and economic loss. Detailed ground measurements, which include soil moisture, leaf area, reflectance, leaf-water potential, and disease severity are being made on test sites in Riley, Finney, Harvey and Russell Counties. Data collection platforms are placed in commercial wheat fields. Transmitted data are soil moisture, maximum and minimum temperature, relative humidity, hours of free moisture and reflectance. These data are to be used to predict disease severity 30 days in advance.

TITLE: REGRESSION OF FOREST GROWING STOCK CHARACTERISTICS ON IMAGES OF SATELLITE PICTURES (MMC # 580)

PRINCIPAL INVESTIGATOR:

Dr. Kullervo Kuusela
Forest Research Institute
Unioninkatu 40 A
00170 Helsinki 17, Finland

SUMMARY: The investigation is concerned with the inventory and classification of forest growing stock. The data of first hand interest is the correlation between the tonal qualities of various satellite pictures (bands) and forest characteristics measured in the field. The final interest is to estimate the benefit obtainable from ERTS A pictures for forest inventory purposes. Test site is located in northern Finland around the point with latitude 68°N and longitude 26°E.

TITLE: DEVELOPMENT OF A MULTISTAGE FOREST SAMPLING SYSTEM USING ERTS-1 IMAGERY

PRINCIPAL INVESTIGATOR:

Philip G. Langley
Earth Satellite Corporation
2150 Shattuck Ave.
Berkeley, Calif. 94704

SUMMARY: The objectives of this investigation are to develop (1) advanced multistage sampling techniques which most fully use the data available from ERTS-1 imagery, (2) coordinate transforms for transferring ownership boundaries from maps to ERTS-1 imagery, and (3) machine methods for extracting forestry related features from ERTS-1 imagery that would be useful in formulating sampling probabilities for forest surveys. Sample ground data obtained from an ownership of 500,000 acres will be used in the final stage of a trial forest survey to determine if data extracted from ERTS-1 imagery can be used to reduce the variation inherent at the first stage of sampling. To accomplish this, the property boundaries will be annotated on the ERTS-1 imagery to establish a sample frame. Sampling probabilities will be formulated from data extracted through the interpretation process. Estimates of total forest volume will be obtained using aerial and ground data already in hand. Tests will be performed to determine if ERTS imagery can be used to significantly reduce the variation encountered at the first stage. Tests to determine the relative effectiveness of different interpretation systems will also be performed.

TITLE: A STUDY OF THE UTILIZATION OF ERTS-A DATA FROM THE WABASH RIVER BASIN (SR # 049)

PRINCIPAL INVESTIGATOR:

Dr. David A. Landgrebe
Laboratory for Applications of Remote Sensing
Purdue University
West Lafayette, Indiana 47906

SUMMARY: This interdisciplinary study is to test the applicability of automatic digital data processing techniques for identifying, classifying and mapping natural and manmade resources in the Wabash River Basin using ERTS-A multispectral scanner data. The natural cover type categories which are to be investigated are: vegetative species including major crop types, forest and woodlots; soil types; and water resources. The crop type analysis is of interest to the Agricultural Stabilization and Conservation Service (ASCS) and the Statistical Reporting Service (SRS) within the U. S. Department of Agriculture and was planned in cooperation with these agencies. Forest and woodlot mapping experiments are of major interest to the Forest Service and the soil and watershed experiments are being conducted in cooperation with the Soil Conservation Service (SCS) and the Purdue University Agronomy Department. Manmade structural features are to be studied in an urban land use analysis of Marion County (Indianapolis), Indiana in cooperation with planning and zoning and metropolitan development agencies for that county.

The test site area encompasses 33,100 square miles of the Wabash River Basin from which subsites will be selected for detailed analysis. Digital pattern recognition techniques using both the spectral and temporal measurements made available by the repetitive coverage of the ERTS multispectral scanner will be utilized in the analysis.

TITLE: EVALUATION OF REMOTE SENSING AS A MANAGEMENT TOOL IN CONTROLLING PINK BOLLWORM IN COTTON

PRINCIPAL INVESTIGATOR:

Dr. Lowell N. Lewis
Citrus Researeh Center
Agricultural Experiment Station
University of California
Riverside, California 92502

TITLE: DESERT PLANT SPECIES IDENTIFICATION BY BY SPECTRAL SIGNATURES

PRINCIPAL INVESTIGATOR:

Dr. Charles H. Lowe
Dept. of Biological Sciences
University of Arizona
Tucson, Arizona 85721

TITLE: REMOTE SENSING IN IOWA AGRICULTURE

PRINCIPAL INVESTIGATOR:

John P. Mahlstede
Iowa Agriculture Experiment Station
Iowa State University
Ames, Iowa 50010

TITLE: TO ASSESS THE VALUE OF SATELLITE IMAGERY IN RESOURCE INVENTORIZATION ON A NATIONAL SCALE (SR - 9616)

PRINCIPAL INVESTIGATOR:

Dr O.G. Malan
National Physical Research Laboratory
Council for Scientific and Industrial Research
P.O. Box 395
Pretoria, Republic of South Africa

SUMMARY: This multidisciplinary experiment involves also the Soil and Irrigation Research Institute and Botanical Research Institute of the Department of Agricultural Technical Services, Geological Survey of the Department of Mines as well as the Department of Planning in cooperation with several university departments of Geography and Regional Planning.

The investigation will involve visual interpretation with ground control of single and multiband ERTS-1 MSS and RBV imagery which will be supplemented by simultaneous high-level colour infrared and conventional aerial photography of selected sites. ERTS-1 imagery will be critically correlated with the results of completed detailed and general surveys within the primary test sites: Central Transvaal, Northern Natal, Northern Free State and Western Cape Province.

By extrapolation of the results obtained within these areas to relatively unexplored areas, it is hoped that synoptic national coverage by ERTS-1 imagery will contribute significantly towards the revision, completion and acceleration of national soils, plant ecological, agricultural land capability, geological and land use surveys at scales of 1 : 250 000 and smaller.

TITLE: SURVEYING NATURAL AND CULTURAL RESOURCES

PRINCIPAL INVESTIGATOR:
Dr. Fernando de Mendonca
Instituto de Pesquisas Espaciais-INPE
Caixa Postal 515 - São José dos Campos São Paulo- Brazil

SUMMARY: An area of about 1,000,000 $km^2$ will be covered with ERTS sensors (4 MSS channels and 3 RBV channels) that will provide images (Precision and Bulk) and magnetic tapes. The area comprises the State of Minas Gerais, São Paulo, Paraná, Espírito Santo and Rio de Janeiro and exhibits a big variation of soil types, plant coverage, agricultural practices and conditions and climate. The area is of paramount importance to the economy of the country. The purpose of the investigation will be to study the viability of scientific uses and economical substitution of the conventional methods of surveying natural and cultural resources by satellite data. Six repetitive coverages were required to make possible the estimation of the dynamic changes in the ground features throughout a year of experiment. Recent aerophotogrammetric survey carried out by Brazilian Agencies and INPE aircraft equipped with several sensors will be used as support of the orbit data. Visual and automatic photointerpretation studies will be carried out, establishing keys for development of an improved automatic data processing system.

TITLE: EFFECTIVE USE OF ERTS MULTISENSOR DATA IN THE GREAT PLAINS (MMC#119)

PRINCIPAL INVESTIGATOR:
Victor I. Myers
Director, Remote Sensing Institute
South Dakota State University
Brookings, South Dakota 57006

SUMMARY: The purpose of this scientific experiment is to investigate data from ERTS sensors in order to develop capabilities for an operational system, using satellite sensor data, in the assessment and management of earth resources in the Northern Great Plains. Rangeland, crops, soils and pattern recognition will be studied with specific emphasis on seasonal differences which occur in a progressive manner related to latitude. Repetitive satellite imagery will afford the opportunity to record the time discriminant parameters influenced by growth stages and hence to assess the influence of maturity and other plant conditions. Eight primary test sites are being studied. These are either experiment stations with long histories of operation and extensive current programs, or are current remote sensing sites. Multi-stage data are being collected, from ground truth, progressing through low, intermediate and high altitude aerial coverage to satellite imagery. Direct image analysis techniques, including level slicing and enhancement methods, have been developed to accomodate the vast amount of data available. The objective of this study is to develop the base system for specific research directly related to realization of operational satellite remote sensing of the specified earth resources in the Great Plains.

TITLE: USE OF ERTS DATA FOR A MULTI-DISCIPLINARY ANALYSIS OF MICHIGAN RESOURCES; TASK I -- EVALUATION OF FORESTS AND RELATED NATURAL RESOURCES

PRINCIPAL INVESTIGATOR:

Dr. Wayne L. Myers
Assistant Professor
Department of Forestry
Michigan State University
East Lansing, Michigan

SUMMARY: The purpose of this project is to assess the potential for application of ERTS data in management of Michigan's forests and related natural resources. This is a three-part program. The objective in the first phase is to assess the utility of manually interpreted satellite imagery in hardcopy form for evaluating gross characteristics of natural resources and large scale stresses such as the red-humped oakworm outbreak on the Manistee National Forest. The objective in the second phase is to conduct a test of automated type recognition, cover mapping, and area computation. The best satellite data for Lower Michigan will be processed on the digital and/or analog computer facilities at Willow Run Laboratories. The features under study in this second phase will be much smaller than those in the first phase, so the effects of limited resolution will become much more obvious. The final phase is dependent on the productivity of the first two phases. Assuming that the above investigations produce reasonable success in evaluating the composition and condition of more or less extensive forest stands, the application of ERTS data to urban forestry will be explored.

TITLE: A STUDY TO EXPLORE THE USE OF ORBITAL REMOTE SENSING TO DETERMINE NATIVE ARID PLANT DISTRIBUTION

PRINCIPAL INVESTIGATOR:

William G. McGinnies
Office of Arid Lands Studies
University of Arizona
1201 E. Speedway
Tucson, Arizona 85721

TITLE: ENGINEERING ANALYSIS OF ERTS DATA FOR SOUTHEAST ASIAN AGRICULTURE

PRINCIPAL INVESTIGATOR:

Prof. J. Arthur McNair
Hollister Hall
Cornell University
Ithaca, New York 14850

TITLE: OBSERVATIONS OF PLANT GROWTH AND ANNUAL FLOODING IN THE INLAND DELTA OF THE NIGER RIVER, W. AFRICA

PRINCIPAL INVESTIGATOR:

Dr. Norman H. Macleod
American University
Mass. & Neb. Aves.,N.W.
Washington, D.C.

TITLE: DETECTION OF PLANT DISEASES AND NUTRIENT DEFICIENCIES; SOIL TYPES ; AND MOISTURE

PRINCIPAL INVESTIGATOR:

Dr. W.L. Parks
Agronomy Dept.
University of Tenn.
Knoxville, Tenn. 37916

DISCIPLINE: AGRICULTURE

TITLE: TESTING THE FEASIBILITY OF DETECTING POTENTIAL LOCUST BREEDING SITES (MMC 032)

PRINCIPAL INVESTIGATOR:

Mr. D. E. Pedgley
Centre for Overseas Pest Research
College House, Wrights Lane
London W8 5SJ, England

SUMMARY: Sites for breeding by the Desert Locust are determined by (a) the occurrence of rains sufficient to wet desert soils to a depth of at least 10 cm so that moisture absorbtion by eggs laid in the soil can lead to successful incubation; and (b) the subsequent growth of vegetation sufficient to be used as food and shelter by both parents and newly-hatched nymphs. Current methods of ground and aerial survey for breeding sites are incomplete and expensive. An alternative method will be tested using ERTS-1 to locate areas in the desert of south-western Saudi Arabia that have been recently wetted by rain or where vegetation has become greener. Changes in colour and albedo will be compared with changes in soil moisture and vegetation routinely monitored at a set of 50 sampling points by a survey team operated jointly with the Locust Research Station of the Saudi Ministry of Agriculture and Water Resources. If detection is proved feasible, then an operational earth resources satellite would greatly aid routine surveying and forecasting, thereby allowing the limited number of conventional survey and control teams to be more effectively deployed, particularly during periods of plague upsurge.

TITLE: INVESTIGATIONS USING DATA FROM ERTS-A

PRINCIPAL INVESTIGATOR:

Prof. P.R. Pisharoty
Indian Space Research Organization
C/O Physical Research Laboratory
Ahmedabad-9, India

SUMMARY: This experiment is concerned with the use of ERTS pictures over the area 8°N to 30°N, 65°E to 85°E and 0°-15°N to 42°E to 55°E. Pictures will be analyzed with sophisticated equipments like microdensitometer, optical mixers, IBM 360/44 computer etc for use in the fields of Agriculture, Forestry, Oceanography, Hydrology, Cartography & Geology. The Principal Investigator has drawn Co-investigators from various Government Institutions in India dealing with the above disciplines. These Institutions normally collect ground observations on a routine basis in their respective fields. The main objective of the studies of the pictures will be to gather as much information as possible about crops, water and mineral resources and their changes with the time. To a limited extent, special ground and aircraft observations will be made for the determination of ground truth.

TITLE: AGRICULTURE/GEOGRAPHY/GEOLOGY/SOIL SURVEY LAND USE - THEMATIC MAPPING - LAND FORM ANALYSIS IN SPAIN

PRINCIPAL INVESTIGATOR:

Dr. Carlos Roquero
Escuela Tecnica Superior
De Ingenieros Agronomos
Univ. Politechnica De Madrid
Madrid, Spain

TITLE: MONITORING VERNAL ADVANCEMENT AND RETROGRADATION (GREEN WAVE EFFECT) OF NATURAL VEGETATION IN GREAT PLAINS CORRIDOR (MMC # 667)

PRINCIPAL INVESTIGATOR:

Dr. J.W. Rouse, Jr.
Remote Sensing Center
Texas A&M University
College Station, Texas 77843

SUMMARY: This experiment is concerned with the phenological parameters of the Mixed Prairie region of the central U.S., extending from south Texas through North Dakota. Natural vegetation systems, primarily rangeland species are being used as phenological indicators. Eight primary and two secondary test sites are employed; at least one site in each of six adjacent states forming the north-south Great Plains Corridor. The vernal advancement and retrogradation (green wave effect) of natural vegetation is being charted as a function of time using both ground observations, including biomass sampling, and spectral signatures from the ERTS-A MSS sensor. Detailed records of weather conditions at each site are also being acquired. A computer program has been developed to locate the test site data within the total MSS data frame, to compute the mean and covariances of the test site data by selected subareas of the site, and to plot the "green wave" characteristics from the MSS data. The analysis will employ MSS images and digitized records. The results are expected to be directly applicable to rangeland management in the Great Plains, and to provide information relevant to crop management decisions, such as optimum planting periods.

TITLE: INVENTORY AND MONITORING OF NATURAL VEGETATION AND RELATED RESOURCES IN AN ARID ENVIRONMENT (MMC# 311)

PRINCIPAL INVESTIGATOR:

Barry J. Schrumpf
Rangeland Resources Program
Oregon State University
Corvallis, Oregon 97331

SUMMARY: Incorporation of ERTS-1 data into vegetation inventory procedures will be investigated. Kinds and amounts of vegetations representing shrub-, grass-, and woodlands of southern Arizona will be determined through a multistage sampling technique utilizing ERTS imagery at the first stage. Studies of relationships of vegetation distributions to geomorphic characteristics of the landscape, and of plant phenological patterns to vegetation identification on satellite imagery are expected to contribute to ERTS data interpretation. Comparison will be made of the facility with which landform identifications can be made using low sun angle monoscopic versus high sun angle stereoscopic techniques. Apparent spectral signatures of some vegetation types will be determined from digital MSS data. Collaboration is planned with personnel from the Arizona Regional Ecological Test Site; Forestry Remote Sensing Lab, U.C., Berkeley; and the Environmental Remote Sensing Applications Lab, O.S.U., Corvallis, Oregon.

TITLE: METHODS OF UTILIZING MULTISPECTRAL SATELLITE IMAGERY FOR WILDLAND RESOURCES EVALUATION IN THE GREAT BASIN.

PRINCIPAL INVESTIGATOR:

Dr. Paul T. Tueller
Renewable Resources Center
University of Nevada Reno
Reno, Nevada 89502

SUMMARY: The principal objective is to investigate the usefulness of MSS and RBV imagery from the ERTS satellite as supplementary tools for the management of renewable natural resources in the Great Basin. A key will be developed to broad natural vegetation units within the Great Basin and these units will be related to soil order and landform. Spectral reflectance on RBV and MSS imagery will be compared to vegetation maturation over large land areas for a complete growing season. This will hopefully give an indication of dynamic events affecting management such as range readiness, fire fuel estimates or phreatophyte activity along stream channels. A map of natural vegetation in Nevada will be composed for use by resource managers. Specific bands, dates and color enhancements will be evaluated to determine optimum combinations for feature recognition and mapping.

TITLE: ASSESSMENT OF THE UTILITY OF ERTS DATA IN PLANNING AND INVESTIGATION OF WATER RESOURCE DEVELOPMENT PROJECTS IN THE LOWER MEKONG BASIN (KHMER REPUBLIC, LAOS, THAILAND AND REPUBLIC OF VIETNAM).

PRINCIPAL INVESTIGATOR:

Mr. W.J. van der Oord
Executive Agent
Mekong Committee
c/o ECAFE
Bangkok, Thailand

SUMMARY: The primary purpose of the investigation is to assess the extent to which data from earth resources satellites can be used to compile timely and accurate agricultural statistics for the planning of water resources development projects in the Mekong basin. The imagery obtained will also be processed, where appropriate, for mapping of areas inundated by overbank flooding of the Mekong and its tributaries, land use inventories in potential reservoir sites, and supplementing daily station reports for flood forecasting. No special, sophisticated data handling is envisioned. Positive prints, enlarged 4X-5X in projection will be evaluated, cross-checked and studied for key signatures. A series of ground truth sites has been established at the Mekong Committee experimental farms - five locations in the basin - which will radio coded data, as required, and at the extensive system of hydrologic and meteorological Network stations, which report daily to the Secretariat by radio. Once key signatures are identified, an experimental computer analysis and colour overlay study will be made. It is anticipated that the scale and level of detail of ERTS imagery, together with the full and repetative coverage of the entire area of interest, will provide the Mekong Committee with critical planning data that can be obtained otherwise only at far greater expense, and in some areas not at all under existing circumstances.

TITLE: COFFEE INVENTORY. DEVELOPMENT OF INTERPRETATION TECHNIQUES.

PRINCIPAL INVESTIGATOR:

Marcos Henrique Velloso
Ministry of Industry and Commerce,
Brasilian Coffee Institute-GERCA,
Service of Photointerpretation,
Rua Miguel Pereira,55, Humaitá,
20000 Rio de Janeiro - GB
Brasil.

SUMMARY: This experiment is designed to test the viability of the interpretation of orbital images for studying the dynamic aspects of coffee production such as the variations in planted areas, variations in production and use of modern techniques of planting using repeated short term inventories. The experiment is designed to be completed in the coffee regions of the States of Paraná, São Paulo, Minas Gerais and Espírito Santo which total approximately 620,000 square kilometers and represent about 95% of the Brasilian coffee production. The experiment is broken into two phases: a preliminary phase and an application phase. The first will involve the estimation of the viability of coffee identification, with distinctions in vegetal growth, planting systems, and the determination of the appropriate spectral band/s for the proposed inventory, and well as the establishment of the most suitable time during the season for the most distinct coffee images, by analysis and comparison with images from the different sensors. This phase will be executed in a test area contained between the parallels 22°00' and 23°00'S and longitude 51°00' and 52°00'West. If positive results are partially or fully obtained, during the preliminary phase, an application phase will be initiated in the form of a survey using the satellite imagery, in the coffee regions mentioned above. Correlations will also be completed between the field conditions, the orbital images and the coffee inventories in the regions concerned completed using aerial photographs of the scale 1:60,000 taken in 1965 and the scale 1:25,000 taken in 1971 and 1972. This experiment will receive technical assistance from the Food and Agriculture Organization of UN.

TITLE: CROP IDENTIFICATION AND ACREAGE MEASUREMENT UTILIZING ERTS-1 IMAGERY

PRINCIPAL INVESTIGATOR:

Donald H. Von Steen
Statistical Reporting Service
U. S. Department of Agriculture
Washington, D. C. 20250

SUMMARY: The objectives of this investigation are to develop techniques of crop specie identification and acreage measurement utilizing space imagery. Three sources of information will be used, satellite, aircraft, and ground. The ground data will come from a probability sample of the study areas in Missouri, South Dakota, Kansas, and Idaho. The aircraft data will come from two randomly selected flight lines in each study area. Each source of information could theoretically provide an unbiased estimate of the crop acreage for each study area. It is assumed and critical that the satellite and aircraft imagery provide enough resolution to be able to identify all areas within the primary sampling unit. The first major effort will be to compare the results from the three data sources. The second major effort will be to evaluate alternative ways of using this information in a multistage sample design. The other approach is to use concepts of multiple frame sampling. In this approach, we would attempt to combine all three

sources of data where the ground data would always be complete; satellite data could be complete or incomplete (cloudy or partly cloudy) and the aircraft could be either complete or partially complete. Thus an estimate of the study areas will be available regardless of the cloud conditions. The three information sources in either multiple frame or multistage sampling, together with related costs will point to the most efficient way to use the data. Hopefully, an optimal combination of all sources will show a marked improvement over any one source for making crop acreage estimates.

TITLE: USE OF ERTS DATA FOR A MULTI-DISCIPLINARY ANALYSIS OF MICHIGAN RESOURCES; TASK III--EVALUATION OF SOILS, SOIL CONDITIONS AND LANDFORMS

PRINCIPAL INVESTIGATOR:

Dr. E. P. Whiteside
Department of Crop and Soil Sciences
Michigan State University
East Lansing, Michigan

SUMMARY: The objectives of this subproject are to develop and apply techniques for using remote sensor information as a complementary method to aerial photography and field observations for identifying and mapping soils and landforms and for relating soil conditions and landforms to land use and potential land uses.

Basic soils information is needed for site selections and management decisions having to do with regional and local planning in rural, suburban and urban areas. Soil and landform maps of varying degree of detail, from current medium intensity (4" = 1 mile) to reconnaisance surveys (.04" = 1 mile) of two test sites representative of morainal and outwash areas of major soil associations in terminal and interlobate moraine areas in southern Michigan will be compared with ERTS-A, RB 57, and C 46 remote sensor imagery at two or three different times of the year. Results of studies on these test sites will be applied to production of general soil and landform maps of representative areas within one or two ERTS frames.

Improvements in the accuracy of soil maps or in the economy of obtaining this information would be immediately applicable to environmental maintenance or improvement in suburban and rural areas. In conjunction with Task I, Forest and Related Natural Resources and Task II, Agricultural Crops, the data from Task III may be useful in Regional Land Use Planning and Land Evaluations.

TITLE: TIMBER RESOURCE INFORMATION SYSTEM (TRIS) IN THE PACIFIC NORTHWEST (SR 229)

PRINCIPAL INVESTIGATOR:

Arthur M. Woll
Bureau of Indian Affairs
Washington, D. C. 20242

SUMMARY: Bureau of Indian Affairs, Bureau of Land Management, and State of Washington propose to use aircraft imagery and subsequent satellite imagery from ERTS-A to evaluate remote sensing as an information tool in the high quality forest of the Pacific Northwest. Change detection will be very important in monitoring the effects of management on the forest. Cultural developments will be monitored as to the effects on the environment. In the area of protection, a warning system will be developed for environmental stress and hazard conditions. Preservation, where practiced, will reveal ecological considerations.

This proposal will give the land manager broad delineation of the vegetative resources by ERTS-A imagery. The operational demonstration is to show the utility of these delineations for cost effective inventory sampling schemes, defining data needs, and developing the resource data into timely and meaningful information for the land manager's decisions.

TITLE: REFLECTANCE OF VEGETATION, SOIL, AND WATER (AG #339)

PRINCIPAL INVESTIGATOR:

Dr. Craig L. Wiegand
USDA - Agric. Res. Ser.
P. O. Box 267
Weslaco, Texas 78596

SUMMARY: Emphasis is on developing an operational system of ERTS data analysis suited to the needs of the USDA. Objectives deal with discriminating among various crop and soil conditions, their temporal analysis, and acreage estimates. Scientific objectives compare ERTS data-indicated leaf area indices with analytical model estimates, and determination of whether or not chlorophyll concentration differences in grain sorghum can be detected from orbiting satellites. Hidalgo County has been selected as a test site. Ground truthing is done on 200 160-acre sample sites to obtain county estimates with which to compare ERTS estimates and to supply training fields. MSS digital tapes are the main data source. The maximum likelihood ratio is the primary pattern recognition algorithm employed.

Since LAI is a well-known indicator of plant maturity and vigor, inferences about the health and probable yield of crops should be possible from satellite-acquired data. The expertise gained in data handling and analysis should result in progress toward operational systems for beneficial use of spectral data in agricultural applications.

TITLE: LAND USE, SOIL MAPPING, SOIL-BEDROCK RELATIONSHIPS, EROSION, DRAINAGE, SALINITY LIMITATIONS, FOREST DENSITY AND COMPOSITION.

PRINCIPAL INVESTIGATOR:

Prof. N.J. Yassoglou
Athens Faculty of Agriculture
Botanicos Athens, Greece
and NRC/Democritus, Athens, Greece.

SUMMARY: This experiment is concerned with the land use patterns of the rural areas of Greece, the study of the major soil units of the country in terms of their relationships to parent rock, geomorphology and their limitations such as salinity, erosion and drainage. Estimates of forest cover, composition and density of certain stands are also made.
Existing and new detailed ground truth data are compared with MSS images and computer processed data to develop feature recognition patterns for the studied land forms. The techniques which will be developed and the obtained information will be exploited for more detailed study of the rural resources of the country.

TITLE: A STUDY OF WHEAT IN THE ATLANTIC TEMPERATE ZONE (PHENOLOGY, VIGOR, PESTS AND DISEASES, AND YIELD; COMPARISON WITH DATA FROM INDIANA, USA (MMC # 569-01)

PRINCIPAL INVESTIGATOR:

Dr. J.C. Zadoks,
Laboratory of Phytopathology,
Agricultural University,
Wageningen, The Netherlands

SUMMARY: The main objective of this experiment is a feasibility study to identify wheat grown under temperate atlantic conditions. The correct identification will be influenced by many agronomical variables, like: physiologic growth stage, cultivar, leaf area index, pests and diseases, etc. Locating and identifying outbreaks of pests and diseases, identifying contamination by weeds and identifying self-sown volunteer wheat in the crop-free period will form part of a secondary feasibility study. The whole experiment is situated in the new Zuyderzee polders area with the experimental farm and the agricultural development area of the Zuyderzee Development Authority as the central test site area. The anticipated results are: a statistical measure for radiation characteristics of wheat, an assessment of the variability of this spectral signature according to the influencing agronomical variables and an assessment of the feasibility to find and locate early foci of pests and diseases.

This experiment will be executed in close cooperation with the ZDA (Zuyderzee Development Authority, Kampen, The Netherlands), for obtaining groundtruth, the ITC (International Institute for Aerial Survey and Earth Sciences, Enschede, The Netherlands), and LARS (Laboratory for Agricultural Remote Sensing, Purdue, USA), for the processing of the required RBV pictures and MSS images.

## II. ENVIRONMENTAL QUALITY/ECOLOGY

TITLE: ARCTIC AND SUBARCTIC ENVIRONMENTAL ANALYSES UTILIZING ERTS-1 IMAGERY

PRINCIPAL INVESTIGATOR:

Dr. D.M. Anderson
Chief, Earth Sciences Branch
U.S. Army Cold Regions Research and Engineering Laboratory
Hanover, New Hampshire 03755

SUMMARY: This investigation is designed to achieve five objectives: a. analyze and map the sediment deposition in harbors, inlets, and docking facilities in Cook Inlet; b. map the permafrost areas of Alaska as inferred by vegetative patterns and other indicators; c. compare tonal and textural permafrost patterns visible on ERTS imagery with that of Mariners 6, 7 and 9; d. correlate snow cover with stream runoff on the Caribou-Poker Creek Watershed; e. map and inventory stream icings in the Chena River drainage basin. Cook Inlet is the principal test site for the oceanographic portion of the investigation; a north-south transect between 144° and 154° W. longitudes contains the principal test sites for the permafrost and hydrology portions. Ocean current and suspended sediment measurements, thaw depths, stream runoff, snow depths, air temperature, precipitation, wind speed and vegetation inventories are the principal ground truth measurements being taken. Repetitive underflight photography of selected areas will be taken to supplement the ERTS-1 RBV and MSS imagery. Selected scenes will be subjected to image enhancement techniques as required. Data on snow field coverage, drainage systems and hydrologic-runoff measurements will be useful in developing snow cover-runoff relationships for interior Alaska. The data on sedimentation patterns, ocean currents, sites of erosion and deposition, and nearshore hydrography will be useful in the improvement of navigable waters, harbor construction, siltation problems, and in the development of coastal areas around Cook Inlet. Data on vegetative-permafrost relationships and permafrost distribution will be applied in the planning for land use where natural resources are being utilized and industrial and transportation systems developed.

TITLE: MONITORING WETLANDS AND SHALLOW WATER ECOLOGY ON ATLANTIC COASTAL PLAIN

PRINCIPAL INVESTIGATOR:

Dr. Richard R. Anderson
Department of Biology
The American University
Washington, D. C. 20016

SUMMARY: ERTS-1 MSS and RBV data are being analyzed to determine usefulness for delineating several ecological parameters in wetlands and shallow waters. Included are the following: (1) delineation and mapping of wetlands plant communities with large aerial coverage and establishment of the boundaries of the wetlands ecosystem using sentinal plant species and physical characteristics such as soil moisture; (2) evaluation and classification of wetlands, using vegetational parameters, to provide inventories and establish management priorities including maintenance and preservation of wild life populations; (3) monitoring of wetlands on a regular basis for detection of man-made or natural successional changes which may result in reductions in primary productivity; (4) delineation of shallow water areas and estimation of distribution of submerged vegetation. Three primary test sites in Maryland, North Carolina and South Carolina are employed. In-situ spectral reflectance characteristics of plant species, mud flats, shallow waters, etc., are being collected. A computer program has been developed to analyze these data. Results are expected to provide rapid, region wide methods for analysis of wetlands ecology.

TITLE: STUDY OF THE CAPABILITY OF USING ERTS IMAGERY FOR AIR POLLUTION INVESTIGATIONS

PRINCIPAL INVESTIGATOR:

Dr. A. R. Barringer
Barringer Research Limited
304 Carlingview Drive
Rexdale, Ontario, Canada

SUMMARY: The objective of the investigation is to evaluate the usefulness of the ERTS-A imagery for air pollution observations in Southern Ontario, Canada. Attempts will be made to detect regional trends in air pollution levels resulting from inter-related non-linear complex functions such as (1) population growth (2) industrial activity (3) energy generation (4) rural and urban population distributions (5) shape and size of metropolitan complexes (6) social and economic change patterns (7) prevailing major meteorological conditions (8) introduction of regional and local air pollution legislation. The ERTS multi-spectral imagery will be used in conjunction with ground level air quality measurements to assess the factors (1) to (8) above, which should be of significant influence to show as multi-spectral changes in 100 mile square ERTS image formats.

TITLE: A STUDY ON THE UTILIZATION OF ERTS-A IMAGERY FOR NATURAL RESOURCES INVESTIGATIONS IN THE PHILIPPINES

PRINCIPAL INVESTIGATOR:

Mr. Fernando S. Busuego, Jr.
Director, Bureau of Mines
Manila, The Philippines

SUMMARY: The project aims to develop the institutional framework through which interagency coordination, processing analysis, storage, and end uses of earth resources survey data can be effectively mobilized consistent with the interdisciplinary and multiagency nature of earth resources survey technology. Application of ERTS-A imagery will be tested on the following: tectonic (geologic structural) studies, preparation of photo maps, improvement of base maps, land utilization and coastal and near shore marine studies. ERTS-A imagery using color composite transparencies and single band spectral images will be studied both megascopically and in detail under as much magnification as practical. Linear features such as faults and folds, alignment of volcanoes, delineation and structure of major rock types will be studies, assessed and plotted on the base map prepared from ERTS imagery. Attempts will be made to delineate urban areas, cultivated areas, forested areas and the information will be compared with the existing information.

TITLE: INVEST. COASTAL POLLUTION AND EVALUATE SATELLITE SYSTEM AS ENVIRONMENTAL MANAGEMENT TOOL

PRINCIPAL INVESTIGATOR:

Richard J. Callaway
Pacific NW Water Laboratory
Corvallis, Oregon 97330

TITLE: REMOTE SENSING OF RECLAMATION PROJECTS FROM SATELLITES (SR 208)

PRINCIPAL INVESTIGATOR:

Larry D. Cast
Bureau of Reclamation
Denver Federal Center
Denver, Colorado 80225

SUMMARY: Imagery usage will be directed toward the investigations of proposed projects and the monitoring of completed projects which are located in north-central Colorado. Three primary fields of interest have been selected:

Operation and maintenance--Monitoring existing reservoirs and distribution systems for seepage, algae growth and pollutants in reservoirs, and deposits and influx of silt in reservoirs.

Geologic investigations--Location of geologic contacts, faults, structures and possible geothermal activity.

Agriculture--Soil mapping, determination of high ground water, location of zones of soil salinity, and land uses.

TITLE: ERTS STUDY OF EUTROPHICATION OF INLAND LAKES

PRINCIPAL INVESTIGATOR:

Phillip E. Chase
Bendix Aerospace Systems Division
Bendix Corporation
Ann Arbor, Michigan 48107

SUMMARY: This experiment is concerned with the feasibility of ERTS as a broad survey monitor of the state of eutrophication of inland lakes. The primary indicator is the color of the water. The presence of green or blue-green algal blooms is one color indicator. Other indications are blue (black in the imagery), green and brown lakes. The lake color will be recorded by surface observation (Forel color classification), aircraft color photography and MSS imagery and by ERTS MSS and RBV imagery. Chemical measurements will be made of the test lakes in Oakland County, Michigan to relate color and algal blooms to water quality and enrichment. Correlation of chemical and biological indicators to water color will be performed as well as recording the frequency and intensity of algal blooms. Lakes varying in size from fifty acres to 1100 acres will be used to determine minimum lake size for broad survey monitoring. Computer processing and statistical analysis techniques will be employed using the Computer Compatible Tapes (CCT). The results are expected to be directly applicable to initial categorization and subsequent alert of lakes undergoing cultural eutrophication.

TITLE: CORRELATION OF SATELLITE AND GROUND DATA IN AIR POLLUTION STUDIES

PRINCIPAL INVESTIGATOR:

Dr. E. G. Copeland
Old Dominion University
Research Foundation
Dept. of Geophysical Sciences
Norfolk, Va. 23508

TITLE: DETERMINE THE BOUNDARIES OF A/C AND S/C DATA WITHIN WHICH USEFUL WATER QUALITY INFO CAN BE EXTRACTED

PRINCIPAL INVESTIGATOR:

W.C. Coulbourn
Grumman Ecosystems Corporation
Bethpage, New York 11714

TITLE: ASSESSMENT AND ECOLOGICAL DIAGNOSES FOR HEALTH ACTIONS IN AREA OF CALI, COLOMBIA

PRINCIPAL INVESTIGATOR:

Dr. R.G. Delgado
Health Division
Universidad Del Valle-Cuip
APDO 7169
Cali, Columbia

TITLE: ECOLOGICAL APPLICATIONS OF ERTS-A IMAGERY

PRINCIPAL INVESTIGATOR:

Dr. H.R. DeSelm
Graduate Program in Ecology
408 10th St.
The University of Tennessee
Knoxville, Tennessee 37916

SUMMARY: This research will locate major and minor vegetation-ecosystem interfaces and monitor changes in ecosystem character in rough landscape of the Southern Appalachian Mountains of eastern Tennessee and western North Carolina. The study transect extends from the Great Smoky Mountains across the Great Valley to the Cumberland Mountains. Cyclic phenomena being monitored are 1) winter leaf chlorosis in evergreen trees and shrubs, and 2) location and phenologic development of nearly pure stands of Appalachian hardwood vegetation such as tulip tree. Catastrophic changes in high elevation forests due to the death of fir and mapping of interfaces of known ecosystems presently mapped at scales from 1:633,600 to 1:3600 are to be accomplished. Ground truth, underflights, and scanning of imagery by microdensitometer facilitate comparisons.

TITLE: USE OF REMOTE SENSORS FOR LOCATING AND DEFINING ANOMALOUS-TEMPERATURE ZONES

PRINCIPAL INVESTIGATOR:

Juan Eibenschultz
Federal Electric Power Comm.
Res. Inst. of Electric Power Ind
Mexico, D.F., Mexico

TITLE: MONITORING GROWTH OR DECLINE OF VEGETATION ON MINE DUMPS - (SR-577)

PRINCIPAL INVESTIGATOR:

B.P. Gilbertson
Spectral Africa (Pty) Limited
P.O. Box 2
RANDFONTEIN
Republic of South Africa

SUMMARY: One of the aftermaths of mining activities in South Africa has been the development and growth of mine tailings dumps. Environmental pollution from these dumps may be largely prevented by ensuring that a vegetative growth covers the entire dump. Unfortunately the dumps form a hostile environment and the annual expenses incurred by the Chamber of Mines in promoting the growth of vegetation on mine dumps have increased steadily to over R1M per annum. The growth or decline of this vegetative cover is monitored by both aerial photography and site visits.

This experiment is aimed at determining whether ERTS imagery can be used to distinguish mine dumps with vegetative cover from mine dumps without vegetative cover at three monthly intervals throughout the year. Furthermore, it is desired that the percentage of mine dump area that is covered by vegetation be ascertained. This is to be done by comparing the photographic densities of six selected mine dump images in the various spectral bands. Extensive ground truth will be collected using a mobile laboratory for field reflectance measurements in the spectral region from 350 nm to 1250 nm. Multispectral and conventional aerial photography of the selected mine dumps will be obtained at differing scales, precision processed, and additively viewed for interpretation purposes. It is anticipated that techniques developed during this experiment could ultimately be used to provide management data to the mining authorities with respect to the state of vegetative cover of all the major mine dumps in the Republic.

TITLE: MOVEMENT OF SUSPENDED PARTICLE AND SOLUTE CONCENTRATIONS WITH INFLOW AND TIDAL ACTION (281/282)

PRINCIPAL INVESTIGATOR:

Warren E. Grabau
U. S. Army Engineer Waterways
Experiment Station
P. O. Box 631
Vicksburg, Miss. 39180

SUMMARY: The primary objective is to determine the degree to which flow patterns of sediment and dissolved material concentrations in tidal waters can be detected by multispectral imagery from the ERTS-1 sensors, and from comparably filtered cameras on aircraft at intermediate altitudes (60,000 and 10,000 ft). A secondary objective is to determine the degradation in spectral reflectance produced by transmission through the atmospheric envelope. Four estuarine sites on the Chesapeake Bay, and the connecting canal between the head of the Chesapeake and the Delaware Bays, will be monitored. Approximately 120 sampling stations will be set up where selected water and sediment parameters will be measured concurrently with sensor overpasses. Synchronous meteorological data will be obtained. The facilities of organizations currently conducting biological and physical research in the area waters will be utilized. The spectral imagery will be analyzed by the combination of a scanning microdensitometer and computer programs developed to correlate the satellite imagery patterns. Successive imagery will be compared to monitor movement of suspended particles and solutes.

TITLE: INVESTIGATION OF ENVIRONMENTAL INDICES FROM THE EARTH RESOURCES TECHNOLOGY SATELLITE (MMC #200)

PRINCIPAL INVESTIGATOR:

Dr. Richard S. Greeley
The MITRE Corporation
1820 Dolley Madison Blvd.
McLean, Virginia 22101

SUMMARY: The objective of this proposed investigation is to develop, demonstrate, and verify the capability to calculate indices of specific environmental characteristics from space observations. These indices are of three major types: 1. Shifts in land use with emphasis on: agricultural resources, timber resources, water resources, eroded areas, transportation, construction, strip and open pit mining, other man-disturbed areas. 2. Pollution of inland lakes and rivers with emphasis on: oil spills, algae blooms, other surface observables, silting of dams and waterways. 3. Pollution of urban and rural air with emphasis on: turbidity, spectral reflectivity. Each "index" will be a combination of measurements of one or more parameters observed from space into a number or set of numbers which can serve a useful purpose in characterizing that portion of the environment. These are test sites selected; the greater Harrisburg area and the Scranton-Wilkes Barre area of Pennsylvania. The greater Harrisburg area will be performed in conjunction with Pennsylvania State University.

TITLE: DETERMINATION OF AEROSOL CONTENT IN THE ATMOSPHERE

PRINCIPAL INVESTIGATOR:

Dr. M. Griggs
Science Applications, Inc.
P. O. Box 2351
La Jolla, California 92037

SUMMARY: The objective of this investigation is to demonstrate the feasibility of determining the aerosol content in the atmosphere from contrast measurements of ground features, and from radiance measurements. Theoretical relationships between aerosol content and contrast reduction and radiance have been derived for ideal model atmospheres. These relationships will be investigated with data from MSS images and digitized records. Ground-truth will be obtained with ground-based measurements of the vertical optical thickness of aerosols obtained with a Volz photometer and an Exotech radiometer, at two tests sites at San Diego and the Salton Sea. Ground-truth will also be obtained with low-flying aircraft flights coincident with two ERTS-1 overpasses.

TITLE: INVESTIGATION USING DATA IN ALABAMA FROM EARTH RESOURCES TECHNOLOGY SATELLITE (ERTS-A)

PRINCIPAL INVESTIGATOR:

Dr. Harold R. Henry
Professor and Head, Department of Civil and Mineral Engineering
The University of Alabama
University, Alabama 35486

SUMMARY: The University of Alabama, the Geological Survey of Alabama and the George C. Marshall Space Flight Center are involved in an interagency, inter-disciplinary effort to use remotely sensed multispectral observations to yield improved and timely assessments of earth resources and environmental quality in Alabama. It is a prime goal of this effort to interpret these data and provide information in a format and schedule which is meaningful to and readily useable by agencies, industries and individuals who are potential users throughout the State. The Alabama Development Office under the governor's office is providing liaison with user agencies. Multistage sampling utilizing satellite data, multispectral photography from aircraft flights and ground truth data with emphasis on the data obtained from the DCS platforms will be performed over specific problem areas within the state. These are a corridor from Tuscaloosa to Gadsden including Birmingham and a corridor from Mobile Bay to the confluence of the Alabama and Tombigbee rivers. It is anticipated that a minimum of three and a maximum of six flights over each area will be necessary for application of the multistage sampling techniques. The Alabama Development Office and its regional counterparts in the state's twelve multicounty development districts are cooperating in planning the management of the state's resources. The primary need within these planning units, is for useful and current data relevant in managerial decisions. High on this list of data required is information on land use and environmental quality. A principal objective of this study is to develop effective and timely procedures for processing and interpreting the remotely sensed data and disseminating meaningful information to these and other users.

TITLE: AN INTERDISCIPLINARY ANALYSIS OF ERTS DATA FOR COLORADO MOUNTAIN ENVIRONMENTS USING AUTOMATIC DATA PROCESSING TECHNIQUES (SR # 040)

PRINCIPAL INVESTIGATOR:

Dr. Roger M. Hoffer
Laboratory for Applications of Remote Sensing
Purdue University
West Lafayette, Indiana 47906

SUMMARY: This is an interdisciplinary study designed to test the applicability of digital automatic data processing techniques for identifying, classifying, and mapping major cover types in the Colorado Rocky Mountains, using multispectral scanner data from ERTS-1. Emphasis will be placed on the automatic identification and mapping of forest and alpine cover types, snow cover mapping, and terrain modeling and the impact of land form on spectral response. Preliminary investigations will involve the spectral characteristics of the various cover types and their capability for accurate differentiation. Various pattern recognition and data analysis techniques developed by LARS will be utilized to select those cover types which can be reliably identified and mapped. Automatic classification results will provide both a map and a tabular inventory of the major cover types for this region. These maps will be analyzed for their accuracy utilizing existing cover type maps as guidelines.

This research will be conducted jointly by the Laboratory for Applications of Remote Sensing, LARS at Purdue University and the Institute of Arctic and Alpine Research (INSTAAR) of the University of Colorado. The analysis will concentrate on two test site areas in Colorado.

TITLE: EVALUATE AND UTILIZE SPACE-ACQUIRED IMAGERY FOR OIL POLLUTION DETECTION, MONITORING AND LAW ENFORCEMENT

PRINCIPAL INVESTIGATOR:

Robert Horvath
Environmental Research Institute of Michigan
P. O. Box 618
Ann Arbor, Michigan 48107

SUMMARY: The overall objective of the investigation is to determine feasibility for using space-acquired remote sensor data to assist the U. S. Coast Guard in executing its mission of oil pollution detection, monitoring and law enforcement. Specific objectives include: 1) determination of detectability of small-scale oil slicks associated with normal leakage and/or dumping from vessels; 2) determination of background oil pollution of shipping lanes due to nearby industrial concentrations; and 3) determination of utility for monitoring the extent and spread of major slicks as an aid to damage prevention and cleanup efforts. Analyses will be directed towards defining optimum characteristics for future space-sensors as well as towards evaluating the ERTS sensors. The United States Coast Guard is a co-sponsor and participant in this investigation.

TITLE: MONITORING THE EFFECTS OF RESERVOIRS ON THE ENVIRONMENT (MMC # 341)

PRINCIPAL INVESTIGATOR:

Dr. R.K. Jain
Environmental Systems Branch
U.S. Army Construction Engineering Research Laboratory
Champaign, Illinois 61820

CO-INVESTIGATOR:

University of Illinois
Urbana, Illinois 61801

SUMMARY: This experiment is to determine whether or not the environmental changes that take place in a river basin during the construction and long-term operation of a flood control reservoir can be measured by satellite imagery. The test area is the Sangamon River Basin located in East-Central Illinois. Plot and transect ground data will be correlated with satellite imagery for the following nine parameters: microclimatology, water quality, stream conditions, ground water, flood plain silt accumulation, insects, animals, vegetation and surface configuration. Hopefully models can be developed using the data collected in the test area to predict post-project environmental changes with reasonable accuracy for geographical areas having a similar pre-project environment. If the use of satellite imagery will significantly reduce the costs of data collection and interpretation over this long-term research effort satellite imagery could be used for future planning decisions concerning water resource development throughout the nation.

TITLE: APPLICATION OF ECOLOGICAL, GEOLOGICAL AND OCEANOGRAPHIC ERTS-A IMAGERY TO DELAWARE'S COASTAL RESOURCES PLANNING

PRINCIPAL INVESTIGATOR:

Dr. V. Klemas
College of Marine Studies
University of Delaware
Newark, Delaware 19711

SUMMARY: One part of this experiment utilizes NASA aircraft and satelite imagery to map the vegetation and land use in Delaware's coastal zone. Wetlands maps showing six primary vegetation species have been completed using RB-57 aircraft imagery and multispectral analysis techniques. Changes in land use and vegetation will be monitored using ERTS-A imagery over as long a time period as possible. The land use change projections developed during the study will be used to plan future development of Delaware's coastal resources.

The second portion of this ERTS experiment is devoted to the investigation of frontal systems, boundaries, sediment and pollution dispersion in Delaware Bay. Previous ship - aircraft experiments have shown that frontal systems and boundaries in Delaware Bay have interesting physical properties, such as exceptional stability and sharp discontinuities in sediment concentration, salinity and temperature. Moreover, those boundaries and fronts which are characterized by downwelling, were found to accummulate foam containing lead, mercury and other toxic substances in concentrations exceeding those of average bay water by two to four orders of magnitude.

The ERTS and aircraft imagery is being interpreted by specialists in the various disciplines at the University of Delaware. Thematic maps are being prepared showing vegetation species, land use patterns, boundary-frontal systems, sediment plumes, and pollution slicks with appropriate isoconcentration contours. Ground truth is being collected by six teams in four boats and two low altitude aircraft operating out of the University's Lewes Field Station. Digital photo analysis with multispectral enhancement will be performed by the Bendix Corporation.

TITLE: STUDY OF CARIBOU MOVEMENTS AND WINTER DISPERSAL IN RELATION TO SNOW COVER (SR 110-7)

PRINCIPAL INVESTIGATOR:

Dr. Peter C. Lent
Alaska Cooperative Wildlife
Research Unit
University of Alaska
Fairbanks, Alaska 99701

SUMMARY: This investigation is a feasibility study which will attempt use of ERTS data to monitor large scale caribou movements and concentrations during periods of extensive snowcover. Objectives include identification of grazing areas and trail systems as well as correlation of utilization patterns with seasonal changes in the snowcover distribution of Northeast Alaska. Ground truth data consists primarily of low level aerial surveillance of seasonally selected areas in Northeast Alaska. Cooperating agencies assisting this project are the Alaska Department of Fish and Game and the Bureau of Sport Fisheries and Wildlife.

TITLE: INVESTIGATION OF THE ENVIRONMENTAL CHANGE PATTERN OF JAPAN

PRINVIPAL INVESTIGATOR:

Takakazu Maruyasu
Institute of Industrial Science
University of Tokyo
7-22-1 Roppongi, Minato-Ku
Tokyo, Japan

TITLE: INTERDISCIPLINARY APPLICATIONS AND INTERPRETATIONS OF ERTS DATA WITHIN THE SUSQUEHANNA RIVER BASIN (MMC#082).

PRINCIPAL INVESTIGATORS:

Dr. G. J.Mc Murtry and Dr.G.W. Petersen
Office of Remote Sensing of Earth Resources
Pennsylvania State University
University Park, Pennsylvania 16802

SUMMARY: This is an interdisciplinary project with the geographical area of interest being the Susquehanna River Basin in Pennsylvania. Specific tasks are grouped into five areas of investigation: inventory of natural resources (soils, strip mines, forests) and land use management; geology and hydrology (geologic structure and terrain analysis, mineral resources and exploration, hydrogeology and ground water resources); pollution (envoirnmental effects of power plants, acid mine drainage, air pollution damage); atmospheric effects and climatic mapping; and data processing (photointerpretation digital processing, pattern recognition, man-machine interactive imagery analysis). In addition to a complete photointerpretation laboratory, a digital processing system has been developed with existing programs capable of producing statistical information, applying pattern recognition algorithms, and generating character and line maps. ERTS data to be analyzed will consist of both MSS images and digitized records. The results are expected to be applicable for land use management purposes within the Susquehanna River Basin.

TITLE: A SCHEME FOR UNIFORM MAPPING AND MONITORING OF EARTH RESOURCES AND ENVIRONMENTAL COMPLEXES FROM ERT-S IMAGERY

PRINCIPAL INVESTIGATOR:

Charles E. Poulton
Earth Satellite Corp.
2150 Shattuck Avenue
Berkeley, California 94704

TITLE: REMOTE HAZE DETECTION

PRINCIPAL INVESTIGATOR:

Dr. Ernest H. Rogers
The Aerospace Corporation
P.O. Box 95085
Los Angeles, California 90045

TITLE: DETECTION AND MONITORING VEGETATION DAMAGE ASSOCIATED WITH HIGHWAYS AND HIGHWAY FACILITII

PRINCIPAL INVESTIGATOR:

Ernest G. Stoeckeler
Maine State Highway Dept.
Box 1208
Bangor, Maine 04401

TITLE: DEVELOP A LAND USE-PEAK RUNOFF CLASSIFICATION SYSTEM FOR HIGHWAY ENGINEERING PURPOSES

PRINCIPAL INVESTIGATOR:

Ernest G. Stoeckeler
Maine State Highway Dept.
Box 1208
Bangor, Maine 04401

TITLE: APPLICATION OF REMOTE SENSING IN STUDY OF VEGETATION AND SOIL IN IDAHO (MMC # 313-3).

PRINCIPAL INVESTIGATORS:

Drs. E.W. Tisdale and M. Hironaka, College of Forest, Wildlife and Range Sciences; Dr. M.A. Fosberg, College of Agriculture, University of Idaho, Moscow, Idaho 83843.

SUMMARY: The principal objective is to utilize remote sensing imagery for the purpose of identifying and delimiting natural ecosystem units as expressed by vegetation and soils. Furthermore, we are interested in determining the distribution of soils and vegetation influenced by Pleistocene periglacial climates.

The principal vegetation involved is sagebrush-grass. The basic ecological units are differentiated by various species of sagebrush with various combinations of perennial grass species and associated forbs in the understory.

ERTS photos and those obtained from intermediate and low level flights will be interpreted for identifying and mapping basic and broader ecological units of the landscape. The procedure will be visual interpretation of remote sensing imagery accompanied by ground truths on a number of selected sites where the vegetation and soil had previously been intensively studied.

Results of this investigation will include (1) a vegetation map of the southern part of the state. No detailed map of this area exists. (2) Information on (a) capability to differentiate closely related ecosystems(ecological units) by remote imagery; (b) capability to recognize specific features of soils and physiography as related to vegetation, moisture potential etc. and (c) capability to recognize periglacial features of the landscape.

TITLE: AN EVALUATION OF SPACE ACQUIRED DATA AS A TOOL FOR MANAGEMENT OF WILDLIFE HABITAT IN THE STATE OF ALASKA (SR 235)

PRINCIPAL INVESTIGATOR:

Bill J. Van Tries
Bureau of Sport Fisheries and Wildlife
Washington, D. C. 20242

SUMMARY: The Bureau of Sport Fisheries and Wildlife working through its Northern Prairie Wildlife Research Center, Division of Refuges, and Cooperative Wildlife Research Unit at the University of Alaska will assess the value of ERTS-A data for its utility in monitoring key ecological changes affecting the fish and wildlife resources of Alaska. This State contains some of the best remaining habitat for migratory waterfowl, unique sea birds, terrestrial and marine mammals. Several large national wildlife refuges are located in Alaska. Remote sensing techniques are uniquely suited to Alaskan problems because of the vast and inaccessible nature of much of the State. Data from ERTS-A will be evaluated for recognition and measurement of seasonal changes in migratory bird habitat and the occurrence of leads in sea ice.

Major river deltas are prime duck and goose breeding areas, and phenology of wetland vegetation is one of the prime determinants of waterfowl production. The 100 mile x 100 mile, Yukon Flats and Yukon-Kuskokwin Delta will be monitored beginning prior to snow and ice break-up and through the waterfowl breeding season. To determine habitat conditions for wildlife, gross indications of spectral reflectance intensity (green) from ERTS imagery will be compared with aircraft-obtained multispectral photographs and ground truth data collected on test sites.

Estuarine habitat important to fish and wildlife resources are subject to natural and economically caused changes, and sea ice leads are important for abundance of zooplankton important to fish and marine mammals. ERTS data from test sites in Bristol Bay and in Chukchi Sea will be examined at different times of the year.

TITLE: INVESTIGATION OF THE DISTRIBUTION OF VEGETATION AND WILDLIFE IN BOTSWANA.

PRINCIPAL INVESTIGATOR:

DR. W. VON RICHTER
DEPARTMENT OF WILDLIFE AND NATIONAL PARKS
P. O. BOX 131
GABORONE, BOTSWANA.

SUMMARY: ERTS photography will be used to visually interpret vegetation types against ground truth areas in the Chobe National Park and the Moremi Wildlife Reserve, Northern Botswana. It is hoped to extend the results on a national scale, so that precise identification may be made of major ecological and vegetational interfaces, e.g. the extent of the Okavango Delta, and of regional habitat/ecological types. In order to assist the Department of Wildlife and National Parks in its aim to conserve a good cross-section of Botswana's wildlife, it is hoped that it will be possible to map the seasonal distribution of large game concentrations in the north and south of the country, from a continuing survey of ERTS imagery. Another important aspect of the work is the need to map and identify extensive secondary invasive and degraded ecological types due to human activity.

TITLE: TIDAL AND OCEAN CURRENT DATA FOR MANAGEMENT AND PLANNING OF NEW JERSEY DEPARTMENT OF ENVIRONMENT PROTECTION

PRINCIPAL INVESTIGATOR:

R. Yunghans
Dept. of Environ. Protection
State of New Jersey
P.O. Box 1390
Tranton, New Jersey 08625

TITLE: CENTRAL ATLANTIC REGIONAL ECOLOGICAL TEST SITE - PROTOTYPE REGION ENVIRONMENT INFORMATION SYSTEM (SR 125)

PRINCIPAL INVESTIGATOR:

Robert H. Alexander
U. S. Geological Survey
Geographic Applications Program
Washington, D. C. 20242

SUMMARY: The objectives of the ERTS-A experiment of the consolidated USGS/CARETS Program are to determine the extent to which ERTS-A and correlative aircraft and ground data can be utilized to derive the required land use data sets, and to develop procedures for processing the resulting data quantitatively by geographic area as required by users. The data sets are interpreted in terms of their mutual interaction with processes of the bio-physical environment. Products, including maps and land use data sets aggregated by both planning regions and environmental regions, are then channeled to a community of users through a regional information center. Evaluations in terms of regional priorities are then used to feed back revised requests for remote sensing data and land use analyses. Iteration of this process will result in an improvement of the ability of the CARETS apparatus to respond to regional information needs, thus providing a screening mecahnism for guiding the use of remote sensing technology toward applications that result in improved management of land resources.

Priority attention will be given to areas that are defined by the users as being of critical environmental concern. It is expected that CARETS may serve as a model for the development of remote-sensing based regional information systems elsewhere.

TITLE: EVALUATION OF ERTS-1 IMAGERY FOR MAPPING EARTH SCIENCE DATA

PRINCIPAL INVESTIGATOR:

D.P. Bickmore, M.A.,
Senior Research Fellow,
Experimental Cartography Unit,
6A Cromwell Place,
London, SW7 2DF,
England.

SUMMARY: It is proposed to examine the data through two approaches, digital and visual. Both will be directed towards answering the questions: is certain information present in the imagery, and how exactly can it be extracted? These questions will be answered in relationship to digital ground truth files for a number of features, e.g. geology, land-use, topography, terrain units and soils, over the Upper Thames Valley area of south-central England. The investigation subsumes the question, how accurately can the information be mapped from the data?

In the digital computer approach the first significant problem is the registration of the imagery with the national topographic maps. This is likely to involve pattern recognition and conformal transformation. There will then follow a sequence of ground truth sampling from the digital files and the imagery in combination, recognition of spectral signatures, classification algorithms and mapping. This will be replicated using different approaches to classification. Where recognition is poor, transformation (enhancement) may be applied.

The visual analysis will follow similar lines, although replication will be by alternative photo-interpreters rather than by alternative classification techniques. The maps that are produced, albeit incomplete maps, will be compared with total ground truth as represented by the thematic and topographic maps of the area. The comparisons will be made digitally for both the computer-and the photo-interpreter-generated maps. This will involve digitisation of the map interpretations produced visually.

TITLE: OVERALL EVALUATION OF ERTS IMAGERY FOR CARTOGRAPHIC APPLICATION (SR 233)

PRINCIPAL INVESTIGATOR:

Alden P. Colvocoresses
U. S. Geological Survey
Topographic Division
Washington, D. C. 20242

SUMMARY: As a professional representing the Agency responsible for the domestic mapping program, the author proposes to utilize the results of other ERTS experiments involved with the various facets of cartography. These include photomapping, map revision, thematic mapping, polar mapping and mapping derived from orbital and sensor positional data from which an overall evaluation of ERTS for the production of cartographic products will be made. Criteria to be considered in the evaluation will be based on: geometric fidelity, spatial resolution, spectral discrimination and fidelity, and resulting cartographic products and their utility. Included in the evaluation will be an analysis of the potential of ERTS to develop into an operational cartographic system. User response to experimental cartographic products will be a major basis for this evaluation.

TITLE: GEOMORPHIC AND REGIONAL-GEOGRAPHIC MAPPING

PRINCIPAL INVESTIGATOR:

Prof. J. De Ploey
Katholieke Univ. Leuven
Instit. Voor Aardwetehschappen
Redingenstraat 16 Bis
3000 Leuven, Belgium

TITLE: MAP REVISION AND PROVISION OF BASIC DATA FOR LARGE AREAS OF BOTSWANA.

PRINCIPAL INVESTIGATOR:
W.L. DICKSON
DEPARTMENT OF SURVEYS AND LANDS
PRIVATE BAG 37
GABORONE, BOTSWANA.

SUMMARY: Botswana still has large areas of the country which are as yet unmapped and for which no satisfactory aerial photo cover is available. The ERTS imagery will be invaluable for basic mapping, and the use of rectifyers and enlargers may enable a direct revision of small scale mapping. It will also complete the photographic cover of Botswana and enable updating of existing mapping to be carried out as expeditiously as possible.

TITLE: PROPOSAL TO INVESTIGATE ERTS-A IMAGERY FOR APPLICATION TO THEMATIC MAPPING (SR 116)

PRINCIPAL INVESTIGATOR:

Dean T. Edson
U. S. Geological Survey
Topographic Division
Washington, D. C. 20242

SUMMARY: It is proposed to investigate the application of ERTS-A imagery to the Thematic Mapping System now in the advanced stages of development at the U. S. Geological Survey's Topographic Division Research Center. Hardware implementation of this system, which is based on density ratio detection of corrected multispectral images, is expected to undergo initial operational testing during the Spring of 1972. This system is planned to be responsive to the requirements for the thematic mapping of snow and ice, open water, infrared-reflective vegetation, and the massed works of man.

TITLE: SNOW SURVEY AND VEGETATION GROWTH IN HIGH MOUNTAINS (SWISS ALPS)

PRINCIPAL INVESTIGATOR:
Prof. Dr. Harold Haefner
Department of Geography
Blumlisalpstrasse 10
8006 Zurich, Switzerland

SUMMARY: The project intends to inventory and map the seasonal fluctuations of two major elements of the landscape - the snow and vegetation cover - in the Alps and Prealps of Switzerland during a yearly cycle in its areal extent and interactions. In particular a careful determination of the positions of the temporary altitudinal boundaries is considered with different techniques. Additional research is concerned with the possibilities of a further subdivision of the two elements, establishing criteria for the identification of snow types, glaciers, snow depths, vegetation types etc. These studies will be supplemented by ground truth, aerial surveys and EREP-data. The ultimate goal would be the development of a model of the relations between snow surface and vegetation growth and between snow cover and water runoff, which could be transferred later to other high mountain areas. The project can refer to existing extensive ground control networks on snow-, runoff-, and phenological data, which are complemented by several test sites and profiles across the Alps.

TITLE : RATIONAL USE OF EARTH RESOURCES TO INVESTIGATE IF MODERN TECHNIQUES USING SATELLITES COULD HELP IN ACCELERATING EXPLORATION OF NATURAL RESOURCES. ( SR-0004).

PRINCIPAL INVESTIGATOR :

Prof. Dr. John A. Katili,
The Indonesian National Aeronautics and Space Institute,
Jalan Pemuda , P.O. Box 3048 DKT ,
Jakarta , INDONESIA.

SUMMARY :

The use of ERTS-A RBV- and MSS-images will show whether small scale original data will be successful in composing Photomaps of "sufficiently useful" order in the preparation of various reconnoitary and inventory maps. The area to be comprised is the Indonesian Territory, since the investigation will also prove whether using the imagery could overcome technological as well as scientific problems in providing representative maps for the Inventory of Natural Resources. The multi - disciplinary effort ( with concentration on Geography and Geology ) will employ ground base data to verify the quality level of data reduction from imagery with less than 30% cloud coverage.

TITLE: STUDY OF SAND MOVEMENTS

PRINCIPAL INVESTIGATOR:

Jean-Marcel Hurault
Institut Geographic National
3E Direction
2, Avenue Pasteur
F-94. Saint-Mande, France

TITLE: AN EXPERIMENT IN CULTURAL INTERPRETATION AND MAP REVISION FROM ERTS-A DATA (SR 237)

PRINCIPAL INVESTIGATOR:

William J. Kosco
U. S. Geological Survey
Topographic Division
Washington, D. C. 20242

SUMMARY: Application of Earth Resources Technology Satellite (ERTS) images to revision of standard quadrangle maps at 1:250,000 scale will be investigated, first by studying the imagery to determine and categorize the types of RBV image details which may be correlated to the map details; then by attempting a revision of maps of selected areas of the U.S.A. These maps will represent widely different terrain conditions such as are found in the far Northwest, the California coast, the middle west, and the east coast. Repetitive coverage of these areas will be studied for its value in detecting changes in images on a timely basis.

TITLE: COMPILATION OF TWO PHOTO MAPS OF NAVADA

PRINCIPAL INVESTIGATOR:

Dr. Joseph Lintz, Jr.
Mackay School of Mines
University of Nevada
Reno, Nevada 89507

TITLE: EXTRACTION OF COUNTY AGRICULTURAL STATISTICS FROM ERTS-1 DATA OF KANSAS

PRINCIPAL INVESTIGATOR:

Dr. Stanley A. Morain
Center for Research, Inc.
University of Kansas
Lawrence, Kansas 66044

SUMMARY: The long-term objective of this project is to develop remote sensors at orbital altitudes as data sources for agricultural statistics. The immediate objectives are to identify wheat fields in Finney County, Kansas (including NASA Test Site 76), and to make an assessment of acreage and crop vigor. The relationship between crop yields and weather is well established. Based on ERTS-1 data and available weather records, an assessment of the feasibility of predicting yields will be made. This feasibility will be assessed in terms of accuracy and timeliness vis-a-vis present systems. If successful, the project will provide a model for estimating basic crop statistics and crop yields at regional, national and international scales. Such a model would be especially useful in areas which do not presently have any basic agricultural data collection system.

The basic steps of the project are (1) identification of crop types by probabilistic methods, (2) calculation of acreage for each crop type, (3) assessment of crop vigor, (4) estimation of yield. The results of these steps will then be compared with results available from conventional estimation sources to determine the utility of the procedure.

TITLE: Cartographic Research Programme for Small-Scale Mapping at 1:1,000,000

PRINCIPAL INVESTIGATOR:

Mr. P. G. Mott
Managing Director
Hunting Surveys Ltd.
Elstree Way, Boreham Wood
Hertfordshire, United Kingdom

SUMMARY: The experiment is to carry out comparison tests between existing mapping, the accuracy and completeness of which can be relied on, with that obtained directly from interpretation and photogrammetric techniques using only ERTS imagery combined with a minimum of survey control. The test areas will be selected parts of the United Kingdom taking in a variety of terrain and land-use types. Actual selection of areas will depend upon the timing and quality of the imagery received. The control maps will be the existing 1:1,000,000 and larger scale sheets of the Ordnance Survey which are available for the whole country. The evaluation of satellite imagery for small-scale mapping and map revision will include: Completeness of detail interpreted directly from satellite imagery; locational accuracy of interpreted detail. A comparison of the value of different types of spectral imagery for interpretation of the different features to be mapped. Development of photogrammetric and image enhancement techniques.

DISCIPLINE: POLAR REGION MAPPING

TITLE: THE CARTOGRAPHIC APPLICATION OF ERTS/RBV IMAGERY IN POLAR REGIONS (NO. SR-149)

PRINCIPAL INVESTIGATOR:

William R. MacDonald
U.S. Geological Survey
Chief, Branch of International Activities
2100 "M" Street, N.W.
Washington, D.C. 20242

SUMMARY: Experiments will be conducted to develop techniques to produce cartographic products containing a pictorial record of polar conditions at a known instant of time and at accuracy consistent with research requirements. These map products will have immediate and long-range value in scientific research, polar planning and programming. Ice flow dynamics on a regional scale will be well illustrated by strain lines and crevasse patterns which will be visible on the imagery. The distribution of mountains and nunataks will be apparent and will provide geologic structural information not readily apparent on existing photographs and maps.

Specifically, we will investigate and if feasible, utilize RBV imagery to compile: 1) small- and medium-scale maps; 2) photo supplements in lieu of standard scale mapping; 3) thematic maps of the variations in the sea-ice boundary and rate of deformation of pack ice by analyzing repetitive imager; 4) a synoptic map of both Polar regions to ascertain their true areas and shape; and 5) for monitoring glaciological features such as the Ross, Filchner and Ronne Ice Shelves; 7) to evaluate the resultant products as a tool for scientific investigations; and 8) investigate the use of a Doppler Navigation Satellite System for establishing control for RBV imagery.

TITLE: CARTOGRAPHIC EVALUATION OF ERTS ORBIT AND ATTITUDE DATA (SR 150)

PRINCIPAL INVESTIGATOR:

Robert B. McEwen
U. S. Geological Survey
Topographic Division
Washington, D. C. 20242

SUMMARY: The ERTS Return Beam Vidicon (RBV) system has been geometrically calibrated to allow photogrammetric computations of the satellite orbit position and orientation. The attitude is comparable with data telemetered by the attitude determination system. Approximately 12 scenes will be selected for measurement and processing. The geographic location is unimportant; a cloud-free area with suitable ground control points is desired. The goal is to evaluate the suitability of auxiliary attitude data for cartographic referencing of satellite images. Such a technique is valuable in decreasing the reliance on ground control or existing maps.

TITLE: INVESTIGATION OF ERTS/RBV AND MSS IMAGERY FOR PHOTOMAPPING OF THE UNITED STATES (SR 211)

PRINCIPAL INVESTIGATOR:

Joseph T. Pilonero
U. S. Geological Survey
Topographic Division
Washington, D. C. 20242

SUMMARY: This experiment is within the disciplines of photogrammetry and cartography. The Earth Resources Technology Satellite (ERTS) is expected to yield RBV imagery that NASA will produce in both "bulk" and precision processed image products. The precision images will be cast on a specified map projection and will contain grid reference information. Standard quadrangle formats with ERTS images mosaicked and with enough line map imagery overprinted for user orientation and clarification are planned. The 1:1,000,000 scale has been decided on as the most appropriate scale at which ERTS images should be presented but attempts will also be made to experiment with 1:250,000; 1:500,000 and 1:2,000,000 scale maps.

TITLE: LAND USE MAPPING AND MODELING FOR THE PHOENIX QUADRANGLE (SR 186)

PRINCIPAL INVESTIGATOR:

John L. Place
U. S. Geological Survey
Geographic Applications Program
Washington, D. C. 20242

SUMMARY: The land use of the Phoenix (1:250,000 scale) Quadrangle in Arizona is being mapped using transparencies of the ERTS multispectral images for interpretation. Interpretation is being aided using a Color Additive Viewer to integrate and enhance the images in the green, red, and infrared wave lengths. The land use data will be read off of the map into a computer where it will be combined with socio-economic and environmental already compiled. In order to evaluate the usefulness of ERTS images for updating land use maps, successive images will be compared by "quick flip" procedures to accentuate the differences. This will assist the photo interpreter in detecting change. Statistical analyses can be run comparing the land use changes with socio and environmental factors already stored in the computerized data bank. Maps showing changes in land use can be plotted automatically. Trends in land use change can be studied, particularly when related to such factors as highway development, land ownership, or population growth.

DISCIPLINE: ENVIRONMENTAL GEOGRAPHY/REGIONAL PLANNING

TITLE: APPLICATION OF EARTH RESOURCES TECHNOLOGY SATELLITE DATA TO URBAN DEVELOPMENT AND REGIONAL PLANNING: TEST SITE - COUNTY OF LOS ANGELES

PRINCIPAL INVESTIGATOR:

Surendra A. Raje
Advanced NASA Programs
Space Division, General Electric Co.
Rm. U3230, Valley Forge Space Center
P. O. Box 8555
Philadelphia, Pennsylvania 19101

SUMMARY: This investigation, while validating ERTS 1 Imagery by correlation with Ground Truth over the County of Los Angeles, generates user-oriented product with the General Electric Multi-spectral Information Extraction System (GEMS). The real-time, interactive man-machine operation of GEMS by representative analyst-users provides spectral signatures for objects classes within the test site with the interpreted output from the TV displays and computer files augmenting the CoLA regional planning data base. The Study Team, including the County of Los Angeles Regional Planning Commission Staff, will conduct research in planning methodologies with the first-time ever availability of synopticity and periodicity of satellite data. Aircraft pre- and under- flight imagery will be GEMS-analyzed for multi-stage ground truth, spatial and spectral analyses. Digital products from ERTS 1 will be analyzed later in the project with the next generation GEMS. User evaluation of the investigation

itself will be done by the primary users from the County as well as by secondary and tertiary users from the regional, state and federal agencies with cognizance of and interest in the test site environment. A supplemental effort concerns interpretations techniques development on GEMS.

TITLE: GEOGRAPHIC APPLICATIONS OF ERTS-1 IMAGERY TO RURAL LANDSCAPE CHANGE (162-III)

PRINCIPAL INVESTIGATOR:

Dr. John B. Rehder
Department of Geography
University of Tennessee
Knoxville, Tennessee 37916

SUMMARY: The research project is designed for the monitoring and delimiting of rural landscape changes in eastern Tennessee through the interpretation of ERTS-I imagery. High altitude imagery (RB-57 1:120,000), low altitude imagery (1:10,000), and ground truth data are integrated into the investigation for control and further interpretation. The study area, centered on Knoxville, Tennessee, encompasses a 10,000 square mile area in which two specific test sites are located. One, a 14 x 14 mile site on the Cumberland Plateau, is for use in observing forest and strip mining changes. The other test site (16 x 21 miles) is centered on Knoxville for use in investigating urban and suburban encroachment on rural landscapes. The ultimate objective of the investigation is to identify, delimit, and map dynamic photomorphic regions of landscape changes; specifically: (1) areas of forest alteration/newly cleared land, (2) areas which exhibit dynamic agricultural landuse change during the seasonal-annual cycle, (3) gross patterns of constructive non-agricultural change, e.g. roads, new settlements, new construction, and (4) sites of destructive alterations of physical and cultural landscapes, e.g. natural and man-made hazards of flood, fire, erosion.

TITLE: ANALYSIS OF HAYA HABITAT

PRINCIPAL INVESTIGATOR:

Priscilla Reining
Research Institute for
Social and Behavioral Sciences
Catholic University of America
Washington, D.C. 20017

TITLE: MANAGEMENT OF NATURAL RESOURCES THROUGH AUTOMATIC CARTOGRAPHIC INVENTORY

PRINCIPAL INVESTIGATOR:

Paul Augustin Rey
Directeur Du Service De La
Carte De La Vegetation
CNRS B.P. 4009-31
Toulouse, France

TITLE: LAND USE PATTERNS ASSOCIATED WITH NORTHERN MEGALOPOLIS

PRINCIPAL INVESTIGATOR:

Professor Robert B. Simpson
Department of Geography
Dartmouth College
Hanover, New Hampshire 03755

SUMMARY: The study is designed to evaluate ERTS as a tool for attaching, at the interregional and interstate level, the problems of our expanding and coalescing cities. Among the specific objectives are the following:

(1) to map and digitize the land use in and around the northern one-third of Megalopolis
(2) to identify critical areas
(3) to predict some of the patterns of future growth, and
(4) to make limited recommendations for improving national land use and land-use planning with the help of satellites.

An important source of background information will be detailed studies of urban land use from RB-57 photography made during 1970-71 with the active support of the NASA-MSC Earth Resources Aircraft Program and the U. S. Geological Survey EROS Geographical Applications Program.

TITLE: CHANGES IN RURAL LAND-USE IN CENTRAL CHILE AND NORTE CHICO

PRINCIPAL INVESTIGATOR:

Mr. René Saa V.
Instituto de Investigación de
Recursos Naturales
Casilla 14995
Santiago, Chile, S.A.

SUMMARY: This program is concerned with the feasibility of using space photography to determine annual and seasonal changes of the land use. The sector of land where evaluation of the feasibility of using spacial images is proposed presents an array of geographical conditions with different land use (irrigated and unrrigated agriculture, extensive and intensive agriculture) and different patterns of rural settlement. Three test sites have been selected. One is located about 500 miles south of the city of Santiago de Chile; the other one is located around the city of Santiago; and the last one is 300 miles north of Santiago. For each test site have been done a detailled land use map. This map is been up date every 36 days. Images from MSS and RBV will be interpreted and later checked with the information provide from test sites. The results are expected to be applicable to an improvement in the agricultural statistical of the main crops and orchards in Central Chile.

TITLE: ANALYSIS OF HETEROGENEOUS AREA IN S. FRANCE FOR USE IN TEACHING

PRINCIPAL INVESTIGATOR:

Dr. J.C. Thomas
Dept. of Anthropology
Catholic University of America
Washington, D.C. 20017

TITLE: MAP TERRAIN FEATURES IN YELLOWSTONE NATIONAL PARK

PRINCIPAL INVESTIGATOR:

Fred J. Thomson
Willow Run Laboratories
The University of Michigan
P.O. Box 618
Ann Arbor, Michigan 48107

TITLE: "CENSUS CITIES" EXPERIMENT IN URBAN CHANGE DETECTION (SR 273)

PRINCIPAL INVESTIGATOR:

James R. Wray
U. S. Geological Survey
Geographic Applications Program
Washington, D. C. 20242

SUMMARY: This experiment seeks to detect and to interpret gross land use change in a sample of U. S. urban areas using remote sensors aboard high altitude aircraft and earth-orbiting satellites. One principal feature of the ground truth phase has been the procurement of multispectral high altitude aerial photography at the time of the 1970 census of population and housing. Similar photography procured in 1972 will form the basis for the change detection and the basis for evaluating the ERTS-A and Skylab imagery. Intermediate products include an information system to receive inputs from both graphic and non-graphic sources. Another product will be a prototype looseleaf Atlas of Urban and Regional Change. Some potential uses and users will be identified.

## IV. GEOLOGY

TITLE: DYNAMICS OF DISTRIBUTION AND DENSITY OF PHREATOPHYTES AND OTHER ARID-LAND PLANT COMMUNITIES (SR 342-I)

PRINCIPAL INVESTIGATOR:

Raymond M. Turner
U. S. Geological Survey
Water Resources Division
P. O. Box 4070
2555 East 1st Street
Tucson, Arizona 85717

SUMMARY: Measurement of seasonal changes in degree of foliation in dominant arid land plant communities will be attempted by use of ERTS-A data. The plant communities will vary from conifer forests of the mountains to desert vegetation of the basal plains. Riparian vegetation at all elevations will be closely studied.

When first available, MSS and RBV data will be utilized to delineate major vegetation types by taking advantage of the differences in season of foliation of dominant species. Foliation should be recognizable through manipulation of data from the several spectral bands. This initial qualitative examination will be followed by attempts to measure the amount of foliage. The quantitative phase of our program will require digital RBV and MSS data.

The proposed analyses will provide the information needed to pinpoint likely areas for livestock grazing, to help identify crop types and wildland communities, and to estimate primary productivity and evapotranspiration in plant communities.

TITLE: IDENTIFICATION AND INTERPRETATION OF TECTONIC FEATURES FROM ERTS-A IMAGERY

PRINCIPAL INVESTIGATOR:

Dr. Monem Abdel-Gawad
North American Rockwell Science Center
Thousand Oaks, California 91360
(805) 498-4545, X192

SUMMARY: The principal objectives of this study are: (1) Appraise the utility of ERTS-A imagery in studying the tectonic framework at major tectonic intersections in U.S. Southwest, Gulf of California, and Red Sea rift areas.
(2) Correlate distribution of earthquake epicenters with faults showing evidence of recent activity. (3) Appraise utility of ERTS imagery in the correlating locations of known mineral deposits to fault zones and intersections.
Our principal test site is the Southwestern United States, including Southern California, Southern Nevada, Arizona, Southern New Mexico, and Northern Mexico.
We will use both RBV and MSS imagery. Computer programs will be used to plot earthquake epicenters and/or mineral deposits on carefully selected photographs. Interpretation of imagery will be made by the standard visual and optical techniques. The principal results are expected to provide much needed information on the location and interaction of active faults in areas of high seismicity and on the correlation of the fault patterns in continental rift zones.

TITLE: UTILIZATION OF ORBITAL REMOTE SENSING FOR GEOLOGICAL MAPPING, SURVEYING FOR MINERAL RESOURCES AND MONITORING RAPID GEOLOGICAL PHENOMENA

PRINCIPAL INVESTIGATOR:

Dr. Gilberto Amaral
Instituto de Pesquisas Espaciais - INPE
Caixa Postal 515 - São José dos Campos
São Paulo - Brazil

SUMMARY: In order to test the applicability of orbital remote sensing for geological problems, an area of about 1,500,000 sq. km in the southeastern portion of Brazil was selected. This area encloses the main industrial centers of the country and is responsible for more than 80 % of its mineral production. It is one of the Brazil's best known regions from the geological point of view. It is intended to extract information on lithology, structure and morphology of the main geotectonic units of the region and their relation with known mineral deposits. It is also aimed to monitor rapid geologic phenomena such as coastal, fluvial and dam sedimentation, and landslides. Efforts will be made to extract tectonic information from the images, in order to support the Brazilian program for the Geodynamics Project. The research will be conducted with emphasis on the development of techniques for automatic interpretation of ERTS-1 data, complemented with visual interpretation. For that purposes several aircraft missions are being carried out on representative test sites.

TITLE: MULTIDISCIPLINARY GEOSCIENTIFIC EXPERIMENTS IN CENTRAL EUROPE

PRINCIPAL INVESTIGATOR:

Dr. Dieter Bannert
Geological Survey of F.R.G.
3 Hannover-Buchholz, Germany

TITLE: GEOLOGICAL STUDY, PHOTOGEOLOGICAL WORK IN OTHER AREAS

PRINCIPAL INVESTIGATOR:

Henri Barkey
Norges Geologiski Underokelsi
P.O. Box 3006
7001 Trondheim, Norway

TITLE: A RECONNAISSANCE SPACE SENSING INVESTIGATION OF CRUSTAL STRUCTURE FOR A STRIP FROM THE EASTERN SIERRA NEVADA TO THE COLORADO PLATEAU (No. SR103)

PRINCIPAL INVESTIGATOR:

Mr. Ira C. Bechtold
General Manager
Argus Exploration Company
4120 Birch Street
Suite 108
Newport Beach, California 92660

SUMMARY: This ERTS-1 investigation is intended to evaluate the application of small scale orbital imagery to studying regional geologic structural patterns and related geologic phenomena. Primary objectives of the research are:

1. Analysis, interpretation, and evaluation of ERTS-1 sensor resolution, scale and spectral range for application to regional geologic reconnaissance.

2. Ground truth field mapping to support interpretative study, and to evaluate significance and practical applications of satellite data.

3. Comparison and evaluation of additionally available remote sensing techniques, including Apollo, X-15 and U-2 photography, side looking aerial radar (SLAR), thermal infrared radiometry.

The test site traverses the Basin-Range province thru portions of California, Nevada, Utah, and Arizona, between 35° and 38° north latitude, and 113° and 119° west longitude.

It is anticipated that ERTS data will provide a basis for synthesis of geologic phenomena not possible by conventional geologic mapping. Potential applications are viewed in exploration for minerals, petroleum, and geothermal energy sources, hydrology, and study of environmental hazards.

TITLE: GLACIOLOGICAL AND VOLCANOLOGICAL STUDIES IN THE WRANGELL MOUNTAINS, ALASKA (110-13)

PRINCIPAL INVESTIGATORS:

Dr. Carl S. Benson and Dr. Lewis Shapiro
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

SUMMARY: The purpose is to study the interaction between volcanic heat and the mass balance of glaciers existing on active volcanoes. It may also be considered as one of the first steps in the general problem of observing geothermal phenomena by satellites. Heat flux measured in sand at the summit of Mt. Wrangell, Alaska (4000m above sea level, 62°N.;144°W) has been shown to be consistent with measured basal melt rates of the glacier ice in contact with volcanic rock and sand. Observations over the past decade have also shown that variations in areal extent and thickness of the snow and ice cover at the summit of Mt. Wrangell can be correlated with changes in the volcanic heat flux.

This experiment will use RBV and MSS images from the satellite together with Infra Red and regular photographic data obtained with the NASA NP3A aircraft. Ground truth studies will be available if other projects on the summit area are funded. DCP's are being requested in connection with extension of this study.

TITLE: STUDY OF LITHOLOGIC AND STRUCTURAL UNITS OF NORTH AFRICAN CRATON

PRINCIPAL INVESTIGATOR:

Serge Beuf
Institut Francais Du Petrole
Geologie Department
1 Ave. De Bois-Preau
92 Rueil Malmaison, France

TITLE: REG. TECTONIC EVOLUTION OF THE TUSCAN APPENIN, VULCANISM, THERMAL ANOMALIES AND RELATION TO STRUCTURAL UNITS

PRINCIPAL INVESTIGATOR:

Dr. J. Bodechtel
Institute Fur Al. and An. Geol. and Min.
Der Universitat Munchen
8 Munchen 2
Luisenstrasse 37, West Germany

TITLE: A PROPOSAL FOR STUDY OF MULTISPECTRAL IMAGERY, ERTS-A, NORTHWESTERN SAUDI ARABIA (SR 480)

PRINCIPAL INVESTIGATOR:

Alfred J. Bodenlos
U. S. Geological Survey
Geologic Division
Washington, D. C. 20242

SUMMARY: It is proposed to study multispectral imagery of tectonic features in northwestern Saudi Arabia and to seek similar structures to the southeast between the crystalline highlands and the coastline of the Red Sea. The control region is the Maqna area, on the peninsula between the Red Sea and the Gulf of Aqaba, where Plio-Pleistocene faults with large vertical displacement have been mapped. Those faults are readily discernable on aerial photographs of standard A.M.S. scale (1:50,000) and can also be seen on uncontrolled color photographs acquired during the manned Gemini and Apollo orbital flights. That region is particularly favorable for such photo-interpretation because of strong color contrast between the dark, uplifted metamorphic rocks and the light, downdropped Tertiary sedimentary rocks. Field reconnaissance in 1968 showed normal faults of Plio-Pleistocene age throughout the Maqna area, running in length from several hundred meters to tens of kilometers and ranging in displacement from tens of meters to more than 1,000 meters. It is probable that the entire Precambrian shield of Saudi Arabia was strongly uplifted in the Plio-Pleistocene along the entire length of the Red Sea, but it is not known whether such deformation took place along individual faults with large displacement or whether it was the result of broad arching of the shield; a third alternative is that both arching and faulting occurred. The investigator will determine if and how the known faults of the control region appear on multispectral imagery of the ERTS-A experiment and will compare that imagery with available standard aerial photography. Follow-on studies for the remainder of the Red Sea border of Saudi Arabia may be proposed at a later date to determine the regional extension of the results of this initial investigation. Field checks would be desirable if new, significant faults associated with the late tectonic development of Saudi Arabia were to be found or indicated.

TITLE: TO TEST AND EVALUATE ERTS-A DATA APPLICATIONS TO GEOLOGIC MAPPING, STRUCTURAL ANALYSIS AND MINERAL RESOURCE INVENTORY OF SOUTH AMERICA WITH SPECIAL EMPHASIS ON THE ANDES MOUNTAIN REGION (SR 189)

PRINCIPAL INVESTIGATOR:

William D. Carter
U. S. Geological Survey
EROS Program Office
Washington, D. C. 20242

SUMMARY: Multiband photographic (RBV) and multichannel scanner (MSS) data which provide repetitive synoptic views of large areas of the earth's surface will provide an opportunity to systematically map the drainage density, geology and structure of remote areas at small scales and begin or update mineral resource inventories in South America. Small-scale (1:1,000,000) orthophoto maps will be constructed to serve as a base for photointerpreted compilation for U. S. and cooperating South American investigators. The advantages and disadvantages of small-scale repetitive observations in all spectral bands will be evaluated in terms of season, weather and frequency of observation. Emphasis will be placed on the major "elbows" or bends of the Andes which have a high incidence of mineral resource occurrences and which appear to be closely related to the edges of major crustal plates. The relationship between these plates and selected areas of the Brazilian Shield will be studied.

TITLE: INTERACTIVE CONTROL OF THERMAL ANOMALIES AND VOLCANIC ACTIVITY AND RELATIONSHIP TO REGIONAL TECTONIC CHARACTERISTI

PRINCIPAL INVESTIGATOR:

Prof. Roberto Cassinis
Lab Per La Geo. Della Litosfera
Geolab, Via Bonardi 15
20133 Milano, Italy

TITLE: EVALUATION OF THE SUITABILITY OF ERTS DATA FOR THE PURPOSE OF PETROLEUM EXPLORATION.

PRINCIPLE INVESTIGATOR:

Dr. Robert Collins
President
Eason Oil Company
5225 N. Shartel Ave.
Oklahoma City, Oklahoma 73118

SUMMARY: The objective of this experiment is to evaluate the contribution of ERTS imagery to understanding the regional geology of large sedimentary basins - particularly the tectonic history of the basin as it relates to hypotheses for oil and gas exploration - and, further, to assess the costs and benefits of using these data and advanced analytical techniques to small and medium sized oil exploration companies. The Anadarko Basin of western Oklahoma and the Panhandle of Texas, chosen as the test site, is similiar to other large sedimentary basins, has a complex tectonic history and is the locus of current oil exploration activity. Data on structural and lithologic features from existing geologic maps and literature will be compiled on overlays showing pre-Pennsylvanian and post-Pennsylvania's features and associated oil and gas fields. Single band and composite imagery products from the ERTS 1 RBV and MSS will be interpreted for geologic features (faults, folds, fractures, outcrops pattern, etc.) using standard photo interpretation techniques, and these features compiled on overlays. These ERTS overlays will be compared to the previously prepared overlays to evaluate the usefulness of ERTS data for detecting Structural features known to be associated with hydrocarbon accumulations as well as previously unknown structural features. Imagery from critical and otherwise interesting area will be enhanced using various electronic, optical, and computer techniques (edge enhancement, color combination, density, slicing) in order to assess the value of these techniques for detecting subtle geologic features or speed interpretation. We expect the results of the experiment to contribute to the over all understanding of the geologic history and tectonic frame work of the Anadarko Basin and to indicate cost benefit relationships of using ERTS type data and advanced analytical techniques to small and medium, sized petroleum exploration companies.

TITLE: GROUND PATTERN ANALYSIS IN THE GREAT PLAINS (NASA PROPOSAL NO. 060, TASK G-3)

PRINCIPAL INVESTIGATOR:

Dr. John C. Davis
Kansas Geological Survey
The University of Kansas
Lawrence, Kansas 66044

SUMMARY: A major objective of the ERTS-A flight will be assessment of reconnaissance satellites for natural resource detection and geologic mapping. Because the areal geology of Kansas is so well known and ground cover is minimal, imagery from orbits over Kansas will provide an opportunity to evaluate and categorize ground patterns. Presumably most ground patterns can be explained in terms of known lithologic, hydrologic, or structural features. Remaining anomalous patterns must be examined and explained so satellite reconnaissance can be applied with surety in areas where ground truth is lacking. Some anomalous patterns may prove to be fictitious, the products of conditions not related to geology such as cultural effects, patches of recent precipitation, and the like. It is possible that other anomalous patterns may reveal geologic features not presently identified or suspected.

Low resolution of RBV and MSS systems preclude most conventional forms of detailed geologic image analysis as applied to aerial photographs, which are strongly dependent on analysis of detailed textural clues. Recognition of geologic phenomena as observed by satellite remote sensing must depend instead more on their multispectral characteristics (i.e., color, tone, etc.) and on gross or regional shape phenomena. Potentially important analytical methods include image combination and enhancement, and spatial frequency filtering to develop a regional or gross pattern synthesis. The potentials of both techniques will be assessed during this study.

TITLE: INVESTIGATION OF LONG RANGE LINEAMENTS AND ITS INTERSECTION (SR-9631/1)

PRINCIPAL INVESTIGATOR:

Carlos Acosta Del Campo
Consejo de Recursos Naturales No Renovables
Niños Héroes N° 139
México 7, D.F. México

SUMMARY: The test site location is an area of 100 by 100 n.m., between 100°00'- 98°15' W.G. Longitude and 20°00'- 18°20'N. Latitude, and includes the periphery and the so called basin of Mexico, with Mexico City in the central part. It is crossed E-W by the main fault systems of the neovolcanic axis (Clarion system). Structural and geologic studies shows that fault intersections located on black shales rocks around the basin are favorable sites for the ocurrence of ore bodies of silver, gold, lead & zinc. The analytical study of the pattern, direction, and relationships of the several fault systems and rock outcrops, presented in the images of the ERTS-1, by visual observation and densitometer technics together with color enhancement by photographic methods will permit to confirm and correct the available tectonic maps, to out on them the lineations and other features observed in the images, and to pin point the fault intersections. This is the starting point to explore by more direct methods the favorable places.

TITLE: PROGRAM FOR STUDIES OF IMAGES OF SHORT LIVED EVENTS

PRINCIPAL INVESTIGATOR:

Dr. W.A. Deutschman
Smithsonian Astrophysical Observatory
60 Garden Street
Cambridge, Mass. 02138

TITLE: INVESTIGATION OF PROTOTYPE VOLCANO-SURVEILLANCE NETWORK

PRINCIPAL INVESTIGATORS:

Dr. Jerry P. Eaton
Dr. Peter L. Ward
U.S. Geological Survey
National Center for Earthquake Research
Menlo Park, California 94025

SUMMARY: The overall objective of this project is to test the design, reliability, and utility of a prototype volcano-surveillance network that monitors seismic activity and tilting of the ground at four volcanoes in the Cascades, three in Alaska, one in Hawaii, four in Guatemala, one in El Salvador, and three in Nicaragua. Multi-level seismic-event counters that count earthquakes of four different sizes will be placed on all volcanoes. Four tiltmeters that fit in shallow boreholes will be installed on only four volcanoes. All data will be relayed via the ERTS-A satellite. Standard seismometers will be operated near most event counters to evaluate the reliability with which these counters compress the seismic data. This system should provide a relatively inexpensive and reliable means for determining which of many "dormant" volcanoes should be studied closely for signs of possible eruptions.

TITLE: BROAD AGR. GEOLOGICAL AND HYDROLOGICAL MAPPING TO BE USED IN LAND MANGEMENT PLANNING

PRINCIPAL INVESTIGATOR:

Carlos A. Espinosa
Institute Geografico Militar
Quito, Ecuador

TITLE: REMOTE SENSING OF PERMAFROST AND GEOLOGIC HAZARD IN ALASKA (SR 207)

PRINCIPAL INVESTIGATOR:

Oscar J. Ferrians, Jr.
U. S. Geological Survey
Geologic Division
345 Middlefield Road
Menlo Park, California 94025

SUMMARY: The wise development of Alaska requires comprehensive evaluation of environmental-geologic data, and the size and remoteness of Alaska inherently make remote-sensing techniques especially well suited for acquiring such data.

In Alaska, permafrost (perennially frozen soil or rock) is an extremely important environmental phenomenon that strongly influences development. Also, geologic hazards such as volcanic eruptions, earthquakes, landslides, flooding, aufeis development, and glacier surges pose special risks.

The principal objectives of this project are to determine the regional distribution and character of permafrost, and to inventory and monitor large-scale geologic hazards, by using ERTS-derived remote-sensing data supplemented with data derived from on-going engineering-geologic investigations. Emphasis will be placed on studying the transportation corridor in northcentral Alaska through which a proposed pipeline, highway, and possible a railroad could be constructed. Eventually all of Alaska will be included.

The information gained by accomplishing these objectives will be an invaluable aid in solving engineering-geologic and environmental problems related to route and site selection for structures such as roads, railroads, pipelines, and large installations; to distribution of natural construction materials; to construction and maintenance; and to availability of ground water.

TITLE: THERMAL SURVEILLANCE OF ACTIVE VOLCANOES USING THE ERTS-1 DATA COLLECTION SYSTEM (NASA #SR 251)

PRINCIPAL INVESTIGATOR:

Jules D. Friedman
Geologic Division
U. S. Geological Survey
Washington, D. C. 20242

SUMMARY: The ERTS-1 data collection systems will be used to relay thermistor-array temperature data from several Cascade Range volcanoes for reduction and interpretation in Wash., D. C. in conjunction with RBV and MSS satellite imagery and calibrated aerial infrared imagery, in a program of volcano thermal surveillance. One goal of the experiment is to determine the practical thresholds of detectability of surficial volcanic thermal anomalies and of geothermal convective heat flow reaching the earth's surface by using several radiance methods. Variations in repose-period volcano temperatures in areas of thermal anomalies will be recorded systematically. Methods to be used will be (1) the DCS of ERTS will record and transmit temperature changes at 3 or 4 active volcanoes; (2) airborne IR scanner surveys will be flown on a systematic schedule; (3) ERTS visible band imagery will be used to determine meterological conditions, visible changes in the Cascade Range, and evidence of eruptive activity of volcanoes in Iceland; (4) Nimbus or other satellite IR thermal-band image analysis of Cascade Range and Iceland volcanoes will be made for evidence of pre-eruptive or eruptive activity.

TITLE: UTILITY OF ERTS-1 IMAGERY FOR UPDATING NATURAL RESOURCE INVENTORIES IN GUATEMALA (MMC #369)

PRINCIPAL INVESTIGATOR:

Dr. Luis E. García M.
División de Recursos de Agua
Instituto Geográfico Nacional
Av. Las Américas 5-76, zona 13
Ciudad de Guatemala
GUATEMALA

SUMMARY: The objectives of the investigation are to assess the operational usefulness of ERTS-1 imagery regarding its practical applications to: (a) Analize the dynamic aspects of inadequate land use, resources and environmental management, in order to better plan for their development; (b) Stimulate other productive sectors, like mining, by means of macrotectonic delineation of the more promising areas; (c) Assess the applicability of the images for geologic reconnaissance; and (d) Develop methods for extending thematic information from mapped to unmapped areas. Variables to be studied include seasonal variations of major crops, habitat of pine-tree species, seasonal tonality of different land use patterns, major geologic structural features and wetland delineation. A test site is to be selected and ERTS-1 imagery will be interpreted visually to determine the extent of consistent identification of indicated variables, and to develop interpretation keys for the operational phase of the study. In this phase, semi-controlled thematic maps will be prepared. A working group of seven has been integrated, with participation from Instituto Geográfico Nacional (IGN) and Dirección General de Servicios Agrícolas (DIGESA).

TITLE: EVALUATION OF FEASIBILITY OF MAPPING SEISMICALLY ACTIVE FAULTS IN ALASKA

PRINCIPAL INVESTIGATOR:

Larry D. Gedney
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

TITLE: GEOLOGICAL LANDFORM ANALYSIS IN CENTRAL PIEDMONT

PRINCIPAL INVESTIGATOR:

Lynn Glover III
Dept. of Geological Sciences
Va. Polytechnic Institute
Blacksburg, Va. 24061

TITLE: APPLICATION OF ERTS AND EREP IMAGES TO GEOLOGIC INVESTIGATION OF THE BASIN AND RANGE - COLORADO PLATEAU BOUNDARY IN NORTHWESTERN AND NORTH CENTRAL ARIZONA (MMC # 308)

PRINCIPAL INVESTIGATOR:

Dr. Alexander F. H. Goetz
Jet Propulsion Laboratory
Pasadena, California 91103

SUMMARY: This investigation has dual objectives: (1) to test the applicability of computer image processed earth orbital images in small scale geological mapping, and (2) to apply the orbital image data to the solution of some geological problems of outstanding scientific interest. The field areas are located in northwestern and north-central Arizona and include areas that already have been intensively mapped, which will be used as ground truth sites, as well as large adjoining areas which are virtually unmapped.

The focal geological problem of this investigation is the origin and late Cenozoic history of the Basin and Range structural province. The structure of a significant segment of the boundary of the Basin and Range province with the Colorado Plateau will be mapped in this investigation. Important evidence on the development of the Basin and Range province is contained in the evolution of the Colorado River drainage system. The record of this geomorphological evolution, in the boundary region to be investigated, is preserved in a series of ancient disrupted drainage channels, partly filled with sediments and volcanic rocks, and in other more widespread fluviatile and lacustrine deposits and lava flows. These deposits will be the object of special study, in an effort to solve the history of the Colorado River and its principal tributaries in the vicinity of the Grand Canyon.

Computer image processing will be used extensively to map geologic units based on spectral reflectivity, enhance regional structures, locate abandoned drainage systems and to test the value of such enhancements in small scale geologic mapping.

TITLE: ERTS DATA AS A TEACHING AND RESEARCH TOOL IN THE DEPARTMENT OF GEOLOGY

PRINCIPAL INVESTIGATOR:

Dr. Donald Grybeck
Department of Geology
University of Alaska
Fairbanks, Alaska 99701

TITLE: IDENTIFICATION OF GEOSTRUCTURES OF CONTINENTAL CRUST PARTICULARLY AS RELATED TO MINERAL RESOURCE EVALUATION (SR 180)

PRINCIPAL INVESTIGATOR:

George Gryc
U. S. Geological Survey
Geologic Division
345 Middlefield Road
Menlo Park, California 94025

SUMMARY: The prime objective of the experiment is to evaluate the usefulness of ERTS-A data in identifying geologic structures and elements of regional extent in Alaska, and in interpreting their significance as keys to the emplacement of known mineral resources, the possible location of unknown mineral resources, and the mechanism and history of formation and deformation of the continental crust in Alaska. Geologic structures, such as folds, faults and fracture systems will be identified by their linear expression as reflected in vegetation, topography, and the disruption of rock units; their identity will be verified where local geology has been mapped on the ground, and their existence extended beyond present knowledge by interpretation of ERTS data. Geologic elements, such as bodies of extrusive and intrusive igneous rocks and sequences of strata having common origin will be identified by tonal character, boundary relations with other elements, and by fracture pattern; identification of like or contrasting sequences not previously recognized will be possible because of the large area covered by a single ERTS image with one tonal range. The significance of these structures and elements as sources of minerals, pathways for their transportation, as favored sites for deposition, or as blocks to deposition will be interpreted in the light of known mineral deposits, providing keys to possible location of similar but unknown deposits, and on a regional scale providing keys to the delineation of mineral provinces--large areas in which one or another suite of minerals or type of deposit typically occurs. In addition, the observed interrelations of these structures and elements will be analyzed, to determine whether significant data are provided to assist in unraveling the geologic history of Alaska, as well as in testing and/or developing the current theory that all geologic elements and structures of Earth result from the interaction between moving crustal plates of continental or subcontinental size.

Interpretation of ERTS-A data will primarily be by visual inspection of color RBV imagery, each image to be studied not only by the PI/Co-I, by also by the geologist of Alaskan Mineral Resources Branch having ground mapping experience in the area covered. Use of instrumentation, such as the Mini Addcol Viewer, will be attempted in the ERTS-B experiment.

TITLE: STUDY GEOMORPHOLOGY, PAST AND PRESENT, LINEAR TRENCH, TECTONICS RELATIONSHIP BETWEEN PYRENEES AND ALPS

PRINCIPAL INVESTIGATOR:

Jacques Guillemot
Institut Francais Du Petrole
4 Avenue De Bois-Preau
92-Bueil-Malmaison
France

TITLE: INVESTIGATION OF THE GEOLOGY OF BOTSWANA.

PRINCIPAL INVESTIGATOR:

DR. J.V. HEPWORTH
GEOLOGICAL SURVEY AND MINES DEPARTMENT
PRIVATE BAG 14
LOBATSE, BOTSWANA.

SUMMARY: Little or nothing is known of the geology of the Kalahari basin in Botswana. National gravity and magnetic surveys have been initiated in 1972 as part of Botswana's contribution to the International Geodynamics Project. ERTS imagery will be examined in the hope that it will support the results of the geophysical surveys. These results will be interpreted in the light of existing seismic data to aid assessment of (a) the Geologic structure and nature of the Kalahari basin and the implications of the S.W.-N.E. trending Ghanzi Ridge and other sub-parallel lineaments, (b) the regional Geologic structure of the extension of the Bushveld Basin structure into Southeast Botswana, (c) the regional trends in the Tectono-Metamorphic complex of Eastern Botswana which could control hitherto unknown sites of mineralisation and (d) the large scale photogeological contrasts between the Rhodesian Craton and the Limpopo Mobile Belt in Eastern Botswana. Visual photo interpretation will be used in comparison with geological and structural maps where available. The importance to Botswana of finding new mineral deposits cannot be overestimated.

TITLE: UTILIZING ERTS-A IMAGERY FOR TECTONIC ANALYSIS THROUGH STUDY OF BIG HORN MOUNTAINS REGION

PRINCIPAL INVESTIGATOR:

Prof. Richard A. Hoppin
Dept. of Geology
The University of Iowa
Iowa City, Iowa 52240

TITLE: ANALYSIS OF ERTS-1 IMAGERY OF WYOMING AND ITS APPLICATION TO EVALUATION OF THE STATE'S NATURAL RESOURCES

PRINCIPAL INVESTIGATOR:

Dr. Robert S. Houston
Department of Geology
University of Wyoming
Laramie, Wyoming 82070

SUMMARY: The ERTS-1 investigation at the University of Wyoming is a multidisciplinary program using combined aircraft and satellite remote-sensor data to inventory Wyoming's natural resources and aid in land-use studies. The objectives of the study include: 1) recognition of geologic features by analysis of spatial and spectral data, 2) development of a synoptic view of the geostructural framework of the state, 3) identification of major forest-grassland-crop types by their spectral signatures, textures, distribution, and contextual patterns, 4) correlation of vegetation with rock and soil types, 5) establishment of criteria for locating and defining selected natural resources using high-altitude remote sensors, and 6) correlation of the resulting information with land-use and environmental considerations in the state of Wyoming.

Various state and federal agencies, operating in the state, who may benefit from these studies are being encouraged to cooperate with the University of Wyoming in the application of the ERTS-1 investigation results to real situations. It is envisioned that this cooperation will serve to familiarize the governmental agencies with the capability of remote sensing with regard to solving particular problems, and will provide the University with a better assessment of the scope of application and practical utility of the remote-sensor data so that project research can be directed accordingly.

TITLE: MONITORING CHANGING GEOLOGIC FEATURES ALONG THE TEXAS GULF COAST

PRINCIPAL INVESTIGATOR:

Dr. Ralph E. Hunter
U.S. Geological Survey
Corpus Christi, Texas 78411

SUMMARY: ERTS imagery will be used in a study of the sources, movement, and deposition of suspended particulate matter in Texas coastal waters and the adjacent Gulf of Mexico. The imagery will provide repetitive, broad, synoptic coverage showing the distribution of turbid water masses. Supplementary imagery obtained by aircraft will be used to measure short-term rates and directions of movement of the water masses and to observe details of turbidity distribution too small to be visible on the ERTS imagery. Release of drift objects will provide further data on water movement. Shipboard measurements of temperatures, salinity, and turbidity through the water column will provide water-truth data for use in the interpretation of the imagery.

Besides defining the paths of suspended sediment movement, a matter of geologic interest, the study will furnish information applicable to studies of physical oceanography, marine biology, and water-borne pollutants.

To the extent that the resolution of the ERTS system permits, the imagery will also be used in studies of shoreline changes and coastal dune movement.

TITLE: SMALL SCALE GEOMORPHOLOGICAL MAPPING OF SAHARA (1/5,000,000)

PRINCIPAL INVESTIGATOR:

Jean-Marcel Hurault
Institut Geographic National
3E Direction
2, Avenue Pasteur
F-94. Saint-Mande, France

TITLE : INVESTIGATION OF GEOLOGIC AND STRUCTURAL FEATURES OF KOREAN PENINSULA (MMC # 570)

PRINCIPAL INVESTIGATOR :

Lee, Joung Hwan, PhD.
Director, Geological Survey of Korea, Ministry of Science & Technology, Seoul, Korea

SUMMARY : This investigation is concerned with the geological and hydrological characteristics of Korean Peninsula and it's surroundings. The detection of unmapped faults, fractures, and any other linear features, the delineation of the igneous intrusive masses and lithologic units might lead to discovery of mineralized zone. The study of distribution of moisture content of land surface might be helpful to reveal the high water table area for irrigation water resources. The study will also be focused to increase our understanding on the characteristics of currents, tides, and sedimentation of Korean continental shelf area.

**TITLE: EVALUATION OF ERTS I DATA AS GEOLOGICAL SENSOR IN GEOLOGICALLY DIVERSE TERRANES OF NEW YORK STATE AND SURROUNDING AREAS**

**PRINCIPAL INVESTIGATOR:**

**Dr. Y. W. Isachsen**
**Geological Survey**
**New York State Museum and Science Service**
**Education Department Annex**
**Albany, New York 12224**

**SUMMARY: The primary goal is to evaluate ERTS imagery as a spectral-geological mapping tool at three scales (from 1:1,000,000 to 1:250,000) in the geologically diverse terranes of New York State and surrounding areas. Tectonic provinces include the essentially undeformed Alleghany Plateau, the Adirondack Dome with its exposed basement (Grenville Foldbelt), the Appalachian Foldbelt with its various subdivisions including the Taconic allochthones and Hudson Highlands, a Triassic fault trough, and the Atlantic Coastal Plain. Stereoscopic and color additive analysis will be made of both ERTS imagery and that obtained for calibration purposes by high and medium altitude aircraft. Spectral anomalies will be studied first by conventional field methods, and, where this fails, by small aircraft at appropriate sun angles.**

TITLE: GEOLOGIC ANALYSIS AND EVALUATION OF ERTS-A IMAGERY FOR THE STATE OF NEW MEXICO

PRINCIPAL INVESTIGATOR:

Dr. Frank E. Kottlowski
Assistant Director and Senior Geologist
New Mexico State Bureau of Mines and Mineral Resources
Socorro, New Mexico 87801

SUMMARY: The objectives of this investigation are two-fold and are as follows:

1. To study ERTS-A images with emphasis on discovering and subsequently investigating previously unrecognized geologic phenomena in New Mexico.

2. To evaluate satellite RBV and MSS imagery as a geologic tool by comparing ERTS-A output with air photos, satellite photos, geologic maps and topographic maps of currently recognized features.

TITLE: IDENT. OF MAJOR TECTONIC ELEMENTS, SNOW LINE FOR WATER MANAGEMENT

PRINCIPAL INVESTIGATOR:

Dr. Franz K. List
Fadultad De Ciencias Geologics
Univ. Mayor De San Andres
Casilla 1851
La Paz, Bolivia

TITLE: QUANTITATIVE CORRELATION OF SATELLITE MEASURED (MSS) REFLECTANCE SIGNATURES WITH CONCURRENT GROUND TRUTH DATA

CO-PRINCIPAL INVESTIGATORS

R.J.P.Lyon and A.A.Green
Dept. of Applied Earth Sciences
Stanford University
Stanford California 94305

SUMMARY: Reflectance signatures of selected test nodes in the area between Stanford and Mono Lake are examined in both the ground based and aircraft mode.The effect of the integration of this data into the field of view of the MSS will be studied and a comparison made with the radiances observed at the spacecraft.This data should then aid in the "calibration" of other reflectance signatures observed in the same ERTS overflight. Measurements will be made under varying atmospheric and seasonal conditions in an attempt to establish the statistical reliability of these signatures for rock and soil discrimination.It is also proposed to investigate the use of multiband information to identify the presence of several surface types within each pixel

TITLE: DELINEATE NATURAL RESOURCES CHARACTERISTICS AND THEIR TEMPORAL AND SPATIAL CHANGES

PRINCIPAL INVESTIGATOR:

Mamadu Konate
Dept. of Mines and Geology
Min. of Ind. Dev. and Public Works
Koulouba, Bamko
Republic of Mali

TITLE: STUDY OF LITHOLOGIC AND STRUCTURAL UNITS OF NORTH AFRICAN CRATON

PRINCIPAL INVESTIGATOR:

J. Marcais
Centre National De La Recherche
Scientifique Et Laboratories
16 Rue Pierre and Marie Curie
Paris 58, France

TITLE: ESTABLISH BASES FOR STUDY OF GEOLOGICAL AND STRUCTURAL FEATURES

PRINCIPAL INVESTIGATOR:

Bruno Mascanzoni
Mexican Petroleum Institute
Av. Cien Metros #500
Esquina Calz Atzcapotzalco, La Villa
Mexico 14, D.F., Mexico

TITLE: GEO. AND MIN. RES. INVEST. OF PUNA CATAMARQUENA Y REG. COMAHUE-PATAGONIA, ARGENTINA

PRINCIPAL INVESTIGATOR:

Dr. J. Eduardo Methol
Div. Nat'l. De Geol. Y Min. Auda
Julio A. Roca 651-10 Piso
Buenos Aires, Argentina

TITLE: MAPPING OF THE MAJOR STRUCTURES OF THE AFRICAN RIFT SYSTEM

PRINCIPAL INVESTIGATOR:

Dr. Paul Mohr
Smithsonian Astrophysical Observatory
60 Garden Street
Cambridge, Mass. 02138

TITLE: A TEST AND EVALUATION OF ERTS-A DATA APPLICATIONS TO A PRESENT-STATUS INVENTORY OF THE POST-1890 A.D. EPISODE OF ACCELERATED EROSION, AND TO MONITORING FUTURE EROSIONAL CHANGES, WITH SPECIFIC REFERENCE TO THE ARIZONA REGIONAL ECOLOGICAL TEST SITE (SR 182)

PRINCIPAL INVESTIGATOR:

Roger B. Morrison
U. S. Geological Survey
Geologic Division
Denver Federal Center
Denver, Colorado 80225

SUMMARY: This study will utilize ERTS-A RBV imagery to determine which spectral bands provide optimum geologic, geomorphic, pedologic, and plant ecologic information about the present cycle of accelerated erosion (which began about 1890 A. D.), in a 18,000 sq. mi. area representative of the Desert Grassland of southern Arizona. The ERTS-A RBV data will be used to map the present distribu-

tion of modern gullies and areas of sheet erosion/deposition and wind erosion/deposition; to map the grass/forb ground-cover vegetation density distribution; and to map the more erodable soil types. Using the repetitive ERTS-A RBV data, future erosion changes will be monitored, erosion rates will be determined, as well as the effects of ameliorative measures, of highway and subdivision construction, etc. The limits of discrimination possible with the ERTS-A RBV data will be compared with those possible with ultrahigh RB-57 and U-2 aerial photographs.

TITLE: EVALUATION OF ERTS-A IMAGERY OF THE GREAT PLAINS IN DETECTING AND MAPPING PLEISTOCENE GLACIAL MORAINES, FORMER RIVER VALLEYS AND RIVER TERRACES, INCLUDING THOSE BURIED BENEATH YOUNGER GLACIAL DRIFT, LOESS, AND EOLIAN SAND (SR 238)

PRINCIPAL INVESTIGATOR:

Roger B. Morrison
U. S. Geological Survey
Geologic Division
Denver, Federal Center
Denver, Colorado 80225

SUMMARY: This study will test and evaluate the applicability of ERTS-A RBV data for synoptic identification and mapping of end moraines of the last glaciation, terraces sequences along main rivers, and ancient (middle and early Pleistocene) glacial moraines and filled valleys that have been buried beneath younger glacial drift and/or loess or eolian sand. Clues relating to these features will be sought on the ERTS imagery and systematically compared with their expression on conventional and ultrahigh (RB-57 and U-2, if available) aerial photographs. The project involves the active participation of 6 midwestern state geological surveys, those of Illinois, Iowa, Missouri, Kansas, Nebraska, and South Dakota. The respective state geologists are co-investigators. Several 1°x1° and 1°x2° areas for study will be selected in each state.

TITLE: A STUDY OF MORPHOLOGY, PROVENANCE, AND MOVEMENT OF DESERT SAND SEAS IN AFRICA, ASIA, AND AUSTRALIA: ERTS-B PROGRAM (SR 131)

PRINCIPAL INVESTIGATOR:

Edwin D. McKee
U. S. Geological Survey
Geologic Division
Denver Federal Center
Denver, Colorado 80225

SUMMARY: One purpose of this investigation of large sand-desert features is to develop a classification based primarily on structure and morphology of deposits. The study is designed to cover major areas of sand accumulation in Africa, Asia and Australia in order to determine broad regional trends and to develop generalizations regarding climatic controls, directions of sand movement and source areas. Data ultimately derived from this analysis should be directly applicable to a better understanding of ancient eolian sand bodies that are important to the interpretation of paleoclimates and paleogeography, and to an understanding of the structural control of groundwater movement, petroleum migration and storage and the concentration of certain minerals.

Recognition of distinctive sand forms, discernible on small-scale photography (EROS-ERTS imagery) should make possible the determination of features characteristic of sand seas in general, as compared with those unique to individual areas. Specifically, it should contribute information on such problems as the relation of dune shape to internal structure and the relation of prevailing (or dominant) wind direction to the shape of sand bodies. Excellent opportunities for this type of investigation are made possible by the comparison of sand seas in widely separated areas, each controlled by numerous distinctive environmental factors.

TITLE: ERTS STUDY OF ECOLOGICAL EFFECTS OF STRIP MINING IN OHIO

PRINCIPAL INVESTIGATOR:

Dr. Wayne A. Pettyjohn
Department of Geology
The Ohio State University
Columbus, Ohio 43210

SUMMARY: This project deals with the geologic and hydrologic problems associated with strip mining of coal in east-central Ohio. Presently neither the surface areas of stripping nor the extent of the drainage system affected by the highly mineralized and acidic water is known. Consequently, effective management and control operations can not be initiated. The primary objectives are to map the stripped areas, to detect, identify and map secondary effects of coal mining, to study the after-effects and compare recovery time and effectiveness with which mined areas are restored to usefulness, and to investigate the feasibility of the transfer of knowledge gained to other strip mining regions in the U.S. Secondary objectives are to determine methods for making use of MSS data from aircraft to supplement and improve utility of ERTS data, to determine effectiveness of ERTS data of statistical image enhancement and thematic mapping software and procedures, and to determine the utility of MSS and RBV data taken together.

TITLE: DYNAMICS OF PLAYA LAKES IN THE TEXAS HIGH PLAINS (342C)

PRINCIPAL INVESTIGATOR:

Dr. C.C. Reeves, Jr.
Department of Geosciences
Texas Tech University
Lubbock, Texas 79409

SUMMARY: The principal objectives are to study the water budget of three select playa lake basins; to relate spectral differences obtained by orbital photography to the water balance ecosystem and geology-geomorphology of playas; and to extrapolate those integrated data to the other playa lake basins on the southern High Plains. Particular ground truth to be acquired includes rainfall, runoff, storage, recharge and the evaporation-transpiration budget of the three select playas. Correlation of space-acquired absorbance-reflectance signatures of soils, soil moisture, plants and surface water with ground truth will be utilized to extrapolate to other playas where ground truth is not taken. By this we intend to develop time-space approximations of soil moisture distribution, storage capacity, storage volume, and water loss of the High Plains playa system.

TITLE: GEOLOGIC AND MINERAL AND WATER RESOURCES INVESTIGATION IN WESTERN COLORADO, USING ERTS-A DATA

PRINCIPAL INVESTIGATOR:

Dr. Robert G. Reeves
Department of Geology
Colorado School of Mines
Golden, Colorado 80401

SUMMARY: Geological investigations using ERTS-1 data are being conducted in western Colorado with the goal of providing useful geologic information for the location, development, and management of the earth resources of the state. The major objectives of the program are: 1) to provide improved interpretation of the major structural elements of the Colorado Rockies; 2) to study the relation of regional tectonics to the localization of economic mineralization and Cenozoic volcanism; 3) to study the regional geomorphic development of the Colorado Rockies; 4) to develop user techniques and procedures for best utilizing ERTS-type remote sensor data; 5) to evaluate the potential application of ERTS-type data to regional earth resources problems; 6) to expand the educational aspect of the Bonanza remote sensing project to include applications of space-acquired remote sensor data to the field of earth resources. ERTS-1 MSS imagery is being analyzed in conjunction with aircraft data and field studies; areas of the Colorado mineral belt, central San Juan Mountains, and Rio Grande rift zone serve as primary test sites. Space and aircraft data are used to extend geologic investigations into lesser-known areas of the state.

TITLE: STUDIES OF THE INNER SHELF AND COASTAL SEDIMENTATION ENVIRONMENT OF THE BEAUFORT SEA FROM ERTS-A (SR 206)

PRINCIPAL INVESTIGATOR:

Erk Reimnitz
U. S. Geological Survey
Geologic Division
345 Middlefield Road
Menlo Park, California 94025

SUMMARY: ERTS data will be used in conjunction with field studies along the northern Alaska Coast, our least-known marine environment. The problems to be investigated include the transport regime of the inner shelf and the associated sedimentary processes as well as the relationships between sea-ice and shelf morphology. The space imagery will supply information on environmental variables in this hostile area including distribution and movement of ice and water, freeze-thaw relationships and sediment discharge.

TITLE: STRUCTURAL AND LITHOLOGIC STUDY OF NORTHERN COAST RANGE AND SACRAMENTO VALLEY, CALIF.

PRINCIPAL INVESTIGATOR:

Dr. Ernest I. Rich
School of Earth Sciences
Stanford University
Stanford, California 94305

TITLE: TECTONIC CHARACTERISTIC STYLES, FRACTURE SYS., AMPLITUDE OF FOLDING ZONES WITHIN BASINS

PRINCIPAL INVESTIGATOR:

J.A. Robbiano
Yacimientos Pet. Fiscales
Gerencia De Exploracion
Avda. Roque Saenz Pena 777
Buenos Aires, Argentina

The first objective will emphasize the study of major structural and topographic features as well as the identification of large zones which have undergone chemical alteration. Short term objectives will be the identification and location of features of interest, while long term emphasis will be directed at mapping, interpreting and evaluating these features. Current Bureau investigations involving specific mining districts, phreatophyte distribution, stratigraphy and tectonic features will be augmented by ERTS-A data. The second objective will be undertaken concurrently with work related to the first objective. ERTS-A image covering selected features in the state will be compared with existing air photos, Apollo and Gemini photos, and maps to determine the usefulness of telemetered satellite imagery as a base for reconnaissance and detailed geologic investigations.

TITLE: A PROPOSAL FOR THE UTILIZATION OF ERTS-A GENERATED PHOTOGRAPHS IN THE EVALUATION OF IRANIAN PLAYAS AS POTENTIAL LOCATIONS FOR ECONOMIC AND ENGINEERING DEVELOPMENT (SR 195)

PRINCIPAL INVESTIGATOR:

Daniel B. Krinsley
U. S. Geological Survey
Geologic Division
Washington, D. C. 20242

SUMMARY: The Iranian Playas are potentially valuable sources of ground water and chemicals, and could be utilized for the enplacement of roads and inexpensive airfields. The playas have not been fully utilized to date because of the lack of adequate knowledge concerning the seasonal changes in their surface and ground water hydrologies and in the physical properties of their sediments. The repetitive coverage of ERTS-A can provide photographs of the Iranian Playas showing seasonal changes in the areal extent and possibly the morphology of the surficial units. Contemporaneously with the ERTS-A spring (maximum wet period) and summer (maximum dry period) overflights, ground truth investigations at "most typical" playas will provide maximum corroboration of photo-interpretation and facilitate extrapolation to unvisited playas.

The anticipated products of this investigation are a dry season map and a wet season map of all the Iranian Playas, seasonal maps of the four ground-checked playas which will include the transitional fall and winter seasons, and special purpose maps reflecting the possible engineering and economic potential of the playas, for their wider utilization. New information concerning the dynamics of playa formation and change, and the relationships among climatic change, hydrology and the physical properties of playa sediments are expected from this study.

TITLE : MAPPING OF LITHOLOGIC & STRUCTURAL UNITS USING MULTISPECTRAL IMAGERY (MMC 351)

PRINCIPAL INVESTIGATOR :

Dr. P. Kronberg
Geological Institute , TU Clausthal
3392 Clausthal-Zellerfeld/W-Germany

SUMMARY : The experiment is concerned with the mapping of lithologic units and structural elements of the Afar-Triangle (Ethiopia) by the use and interpretation of multispectral TV- and MSS-data. By comparing the ERTS-data with field data from recent geological, photogeological, geophysical and geothermal mapping projects it will to be investigated, what additional local and regional information could be gained from multispectral space data. By the use of space imagery the mapping is to be extended into unmapped areas and into the structural frame of the Afar, where the structures of the Red Sea, the Gulf of Aden and the Ethiopian Rift Valley interfere. Space data hopefully will contribute to a better understanding of the mechanism of crustal spreading.

TITLE: ENVIRONMENTAL STUDY OF ERTS-A IMAGERY: LAKE CHAMPLAIN AND VERMONT

PRINCIPAL INVESTIGATOR:

Dr. A. O. Lind
Department of Geography
University of Vermont
Burlington, Vermont 05401

SUMMARY: This is a multi-disciplinary project which will attempt to investigate the potential of ERTS data for: (a) land-use and crop mapping, (b) lake pollution detection, (c) lake current observation, (d) wave-wind relationships on the lake, (e) shore types and changes, (f) identification of ground water recharge zones, and (g) engineering classification of terrain. Included in the project are co-investigators with specialties in limnology, ground-water geology and civil engineering. The various types of information will be obtained by analysis of MSS and RBV imagery. A multi-level sampling based on imagery from supporting aircraft flown at low level and high level (U-2) will be employed. Five test sites in Vermont have been specifically selected to suit the various purposes of this project. Analysis of the imagery will be accomplished using standard photo-interpretation procedures with some modifications. A multispectral viewer with image enhancement capabilities will be employed in most stages of analysis. The project is expected to provide valuable environmental information for the management of Vermont's resources.

TITLE: IRON-ABSORPTION BAND ANALYSIS FOR THE DISCRIMINATION OF IRON-RICH ZONES (SR 9648)

PRINCIPAL INVESTIGATOR:

Lawrence C. Rowan
U. S. Geological Survey
Geologic Division
Washington, D. C. 20242

SUMMARY: During the last 6-7 years, laboratory studies have shown that broad reflectance minima occur in the near-infrared as well as in the visible spectra of iron-bearing minerals. These minima are caused by optical absorption due to electronic transitions in the ferric and ferrous ions. In general, minerals which are deficient in iron do not conspicuously display these spectral features. Thus, there are significant spectral differences between iron-rich and iron-poor minerals, rocks, and soils which can be exploited with multispectral imaging techniques to obtain much greater image contrast between rock and soil types than can be achieved iith conventional broad-band photography.

The main objective of this experiment is to use ERTS-A RBV and MSS reflectance data of southeastern California and central and western Nevada to enhance the image contrast between iron-rich and iron-poor rock and soil types with emphasis on the discrimination of oxidized zones associated with metallic ore deposits. Image analysis will use density slicing for individual bands and analog ratioing of selected bands. Structural analyses will be accomplished by optical spatial filtering ("Laserscan"). The effects of scale, spectral resolution and spatial resolutions, and atmospheric absorption will be evaluated by comparing the results of these studies with analyses of aircraft and Skylab data.

DISCIPLINE: GEOLOGY

TITLE: EVALUATION OF COMMERCIAL UTILITY OF ERTS-A IMAGERY IN STRUCTURAL RECONNAISSANCE FOR MINERALS & PETROLEUM

PRINCIPAL INVESTIGATOR:

Dr. Donald F. Saunders
Services Group
Texas Instruments Inc.
P. O. Box 5621
Dallas, Texas 75222

SUMMARY: The objective of this study is to evaluate from the commercial viewpoint the feasibility of ERTS-A imagery as a medium for interpreting and mapping large-scale structural lineaments in both Precambrian Shield areas and basins containing younger sediments in Alaska and the Western U.S. If this program is successful, the eventual application will be to prepare Continental Plate tectonic interpretations which would be useful to mining or petroleum companies for guiding and/or interpreting reconnaissance prospecting operations.

Previous mapping of lineaments has been limited to available conventional photography at a maximum scale of 1:100,000. This is an expensive and tedious method for regional study. It is believed that ERTS-A imagery, with its large coverage per frame, should appreciably lower the costs for regional studies if it can be used successfully in mapping lineaments. The ERTS-A imagery should provide a unique look at the "forest" without the distraction of the "trees". Additional advantages should accrue from multispectral repeated coverage allowing the optimum season of coverage and the best wavelength regions to be chosen for maximum contrast of structural features. All available individual spectral bands and synthesized color-infrared will be utilized in the form of 9 x 9 positive prints and mosaics for this investigation.

TITLE: A PROPOSAL FOR AN ANALYSIS STUDY OF MULTI-SPECTRAL DATA, ERTS-A, FROM AN AREA IN WEST PAKISTAN (SR 181)

PRINCIPAL INVESTIGATOR:

Robert G. Schmidt
U. S. Geological Survey
Geologic Division
Washington, D. C. 20242

SUMMARY: Several porphyry copper deposits in the desert southwestern United States and northern Mexico, and also one in western Pakistani Baluchistan, are surrounded by areas of red soil related to weathering of disseminated pyrite. These spectral anomalies are generally much larger than the porphyry deposits, and make reasonable targets for detection by orbital sensors.

The proposed project is an attempt to study by multispectral imagery a known area of sulfide mineralization in a desert environment and to seek similar mineralized localities in the same region. The control area is a large low grade porphyry-type copper deposit in western Baluchistan, West Pakistan. This deposit, at Saindak in the Chagai District, is marked by a subtle color anomaly surrounded by a larger contact metamorphic zone. The metamorphic zone is of darker hue and more rugged topography than the surrounding terrain. Other contact metamorphic zones with some associated sulfide mineralization are present in the proposal area; whether significant mineralization or color anomalies are associated with these unexplored metamorphic zones has not been determined, and it is reasonable to expect that undiscovered zones exist in this little-known area.

TITLE: LOCATING THERMAL BOUNDARIES AND BIOLOGICALLY RICH AREAS

PRINCIPAL INVESTIGATOR:

M. Scolari
Bureau De Rec. Geo. Et Min.
Service Geologique National
B.P. 6009
45 Orleans (02), France

TITLE: A STUDY OF COMPUTER MAPPING OF FRESH AND ALTERED (MINERALIZED) BEDROCK TERRAIN USING ERTS-A DATA, AND EVALUATION OF THE EFFECTS OF DIFFERENT ATMOSPHERIC CONDITIONS ON SPECTRAL RADIANCE (SR 194)

PRINCIPAL INVESTIGATOR:

Harry W. Smedes
U. S. Geological Survey
Geologic Division
Denver Federal Center
Denver, Colorado 80225

The project is a continuation of present studies of computer mapping of terrain using multispectral data, extended to an area of extensive exposure of bedrock. Conventional techniques of computer mapping and recent innovations will be used. In addition, it is proposed that atmospheric data be used to assess optimum weighting coefficients for each data channel and for preprocessing techniques. These data will be important in determining how spectral radiance is affected by different atmospheric conditions and by shaded versus sunlit areas, and how important it is to correct for these effects.

The experiments will be directed largely toward determining how many and what kinds of rock types and large-scale geologic structures can be mapped by computer using multispectral data, and what the optimum season and atmospheric conditions are. The test area is about 600 square miles. Mineralized areas in the Cripple Creek district will be studied to determine whether or not ore districts can be delineated, both by computer mapping and by study of images and enhanced images.

The known geologic data will be used as a control. Minimum field studies will be required. The computer maps and the film images will be evaluated for geologic content in determining how well the geology can be interpreted and hence the feasibility of interpreting geology in similar terrain where there is little or no control data. Previously undetected structural and lithologic features will be sought to supplement our knowledge of the region.

TITLE: MAPPING AND ANALYSIS OF SAND DUNE FIELDS AND RELATED EOLIAN EROSIONAL FEATURES IN RELATIVELY INACCESSIBLE REGIONS (MMC #555).

PRINCIPAL INVESTIGATOR:

Prof. H. T. U. Smith,
Geology Department,
University of Massachusetts,
Amherst, Mass., 01002.

SUMMARY: Primary objective of the project is to fill gaps in existing knowledge of the geography and geomorphology of major dune fields in relatively inaccessible and little-known regions. Seven desert areas are to be studied: Namib Desert of South Africa, Libyan and western Sahara deserts of northern Africa, and Tarim Basin, Gobi, Turkestan, and Baluchistan Deserts of Asia. Major dune forms and patterns are to be mapped, analyzed, and related to environmental parameters in so far as these can be interpreted from the photos or ascertained from published literature. Large-scale enclosed basins supposedly due to eolian erosion will be studied also. Results should contribute to the classification of dunes and dune fields, to the interpretation of their historical development, to the interpretation of ancient dune sands in the sedimentary record, and to the understanding of eolian phenomena recorded on Mariner 9 photos of Mars.

TITLE: GEOLOGICAL RESEARCH PROGRAM IN ETHIOPIA

PRINCIPAL INVESTIGATOR:

R.M. Shackleton
Res. Institute of African Geology
University of Leeds
Leeds, England

TITLE: EVAL. OF DATA UTILITY FOR EARTH SCIENCES FROM METHODICAL POINT OF VIEW

PRINCIPAL INVESTIGATOR:

Dr. Harald Svensson
Dept. of Physical Geography
University of Lund
Solvegatan 13
3-22362 Lund, Sweden

TITLE: RELATIONSHIP BETWEEN LINEAMENT SYSTEMS AND MINERAL DEPOSITS IN SWEDEN

PRINCIPAL INVESTIGATOR:

Nils-Bertil Svensson
Norrlandsfonden
Smedjegatan 17
S-951 00 Lulea, Sweden

TITLE: USE OF SATELLITE PICTURES FOR DETERMINING MAJOR GEOLOGIC STRUCTURES RELEVANT FOR ORE PROSPECTING, FINNISH LAPLAND (SR-580-3)

PRINCIPAL INVESTIGATOR:
Dr. Heikki V. Tuominen
Department of Geology and Mineralogy
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SUMMARY: A net of 5 - 50 km wide lineaments, which extend across the Baltic Shield into the surrounding areas of Paleozoic and later rocks, is seen in weather satellite pictures obtained in low sun angle winter conditions. Basic and other plutonic rocks, and ore deposits, ranging in age from 2800 to 350 million years, as well as the borders of major basement units and zones of recent seismicity, aligned with the lineaments, indicate that these are deep fractures which have contributed to the geology of the Shield since Early Precambrian. However, due to the scatter of the elements that form the lineaments, and interference features at their intersections, they are hardly detectable through the details of airborne and ground surveys. The purpose of the experiment is to study whether more information in this respect is provided, directly or indirectly, by ERTS imagery taken at different sun angles and seasons of the year. Each band will be analyzed separately by means of optical filtering (optical data processing) and compared with various ground and aerial maps and photos treated similarly. The test area, situated in central Lapland, is the crossing site of several major fractures.

TITLE : MARSHES, TIDAL FLATS AND TURBID WATERS IN FRENCH ATLANTIC LITTORAL (MMC #031)

PRINCIPAL INVESTIGATOR :

Dr. Fernand Verger
Ecole Pratique des Hautes Etudes
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SUMMARY : The object of this project is to conduct studies on the alluvial zones of the French Atlantic Littoral at a taxonomic scale which can bring out the generalization concerning the nature of those sediments and geomorphic forms; an objective which only orbital photographs may permit our achieving. It is sought to bring about a synthesis of the data obtained from the research work already carried out over a number of years on the very same areas by the principal investigator and the co-investigators, and establish a correlation with the new data provided by ERTS 1. It will be however desirable to obtain the largest possible series as much for the study of turbidity of plumes which change according to the tides, as for the study of alluvial plains, showing seasonal phases. The phenomena studied present a very rapid evolution which has been the principal subject of research carried out upto now. A better overall understanding of these alluvial zones and the origin of the sedimentary forms shall not be limited to theorical interest alone, but shall have possibilities of practical application in numerous fields like agriculture, shell fish breeding and coastal management.

TITLE: STUDY OF MESOSCALE PHENOMENA, WINTER MONSOON

PRINCIPAL INVESTIGATOR:

Kiyoshi Tsuchiya
Science and Tech. Agency
Kasumigaseki
Tokyo, Japan

TITLE: GEOLOGICAL MAPPING IN CONJUNCTION WITH LONG-TERM AERIAL SURVEYING

PRINCIPAL INVESTIGATOR:

Henri Van Der Meer Mohr
Inter. Inst. For Aerial
Survey and Earth Science
Kanaalweg 3
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TITLE: AN ERTS MULTISPECTRAL SCANNER EXPERIMENT FOR MAPPING IRON COMPOUNDS

PRINCIPAL INVESTIGATOR:

Robert K. Vincent
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P.O. Box 618
Ann Arbor, Michigan 48107

SUMMARY: A visible-near infrared ratio technique, similar to the thermal infrared ratio technique applied to silicate rock-type discrimination, has been found useful for mapping iron oxide variations with aircraft multispectral scanner data. This same technique is being attempted with ERTS-A multispectral scanner imagery over the Wind River Range in Wyoming. Precambrian iron ore deposits near Atlantic City, Wyoming are the primary target, with metagabbro dikes in the Louis Lake batholith a secondary target. Both the iron ore and parts of the metagabbro dikes have surface coatings of ferric oxide in varying thicknesses and concentrations. As wavelength increases from a visible to near infrared, ferric oxide displays a rising reflectance, which produces a lower visible-to-near infrared ratio for ferrix oxide than for almost any other mineral. Hence, ferric oxide should appear darker than most other geological targets, but not as dark as vegetation in such a ratio image produced from ERTS data. Ferrous iron compounds should display the opposite behavior if exposed in unoxidized form over areas large enough to be resolved by the ERTS scanner. After correlation for atmospheric effects, the radiances in selected pairs of spectral channels will be ratioed in image form, which should enhance variations in target reflectance across the scene. One side benefit of this ratio technique is that it may also be useful for enhancing the appearance of vegetation in the scene. The technique is fairly insensitive to shadows, and enhances information about chemical composition for any targets that do not have a spectrally falt reflectance in the visible andreflective infrared regions. At best, the iron ore deposits in the Atlantic City, Wyoming area will be discriminated from other background targets. If this can be done, the ratio technique should prove to be useful in the search for iron, nickel, copper, zinc, and some other minerals in poorly mapped geographical areas. In any case, the technique is simple enough to be applied by many other ERTS investigators in the near future, if this ERTS investigation proves that it can significantly contribute to user data interpretation.

TITLE: RESEARCH AND INVESTIGATION OF THE GEOLOGY, MINERAL RESOURCES, AND WATER RESOURCES OF THE STATE OF MARYLAND (MMC #401)

PRINCIPAL INVESTIGATOR:

Dr. Kenneth N. Weaver, Director
Maryland Geological Survey
214 Latrobe Hall
Johns Hopkins University
Baltimore, Maryland 21218

SUMMARY: The basic objective is to aid the Maryland Geological Survey in its research program about the geology of Maryland. Two major applications on which ERTS-A imagery will be used are: 1) Applications in Urban Geology and Land Use in the Baltimore-Washington Urban Area and 2) Applications in Coastal-Estuarine Geology. The Urban Geology Program with the U. S. Geological Survey is to develop geological, hydrological, and mineral resources data and relate the data to land use and environmental problems. Anticipated products include overburden thickness maps, groundwater availability maps, and maps of the geologic factors influencing septic tanks suitability, land fill sites, and general construction. Applications in the Coastal-Estuarine Geology programs deal with rate and quantity of shoreline erosion and relationship to the coastal processes. An inventory of all man-made structures such as inlets, groins, and bulkheading and their effect on the sedimentation pattern will be determined by synoptically mapping the Chesapeake Bay area. ERTS-A MSS and RBV sensors are to utilized for both programs with coordinating underflights of the RB57 and NP3A aircraft. ERTS-A imagery will be coordinated with active ground-truth acquisition programs.

TITLE: ENVIRONMENTAL GEOLOGY AND LAND-USE PLANNING IN THE ST. LOUIS-KANSAS CITY CORRIDOR IN Missouri

PRINCIPAL INVESTIGATOR:

Jerry D. Vineyard
Box 250
Missouri Geological Survey
Rolla, Missouri 64501

TITLE: RESEARCH TO DETECT VARIOUS SIZED LINEAMENTS, TO GIVE CHRONOLOGY IN GEOLOGICAL UNITS, AND TO FIND STRUCTURAL UNITS

PRINCIPAL INVESTIGATOR:

Guy Weecksteen
Bureau De Rec. Geo. Et Min.
Service Geologique National
B.P. 6009
45 Orleans (02), France

TITLE: APPLICABILITY OF ERTS-A TO MONTANA GEOLOGY

PRINCIPAL INVESTIGATOR:

Dr. Robert M. Weidman
Dept. of Geology
University of Montana
Missoula, Montana 59801

TITLE: USE OF ERTS-A DATA IN GEOLOGICAL EVALUATION, REGIONAL PLANNING, FOREST MANAGEMENT, AND SURFACE AND SUBSURFACE HYDROLOGY (MMC # 018)

PRINCIPAL INVESTIGATOR:

Dr. Charles W. Welby
Department of Geosciences
North Carolina State University
P. O. Box 5966
Raleigh, North Carolina 77843

SUMMARY: This investigation is aimed at determining the usefulness of ERTS-A data to various North Carolina State government agencies in their management and planning functions. The basic theme is interpretation and analysis of the data for the purpose of making it useful to these agencies. Three test sites in the three geomorphic regions of the state have been chosen, Asheville, Winston-Salem, and Wilmington. In the course of the investigation we expect to develop techniques and to improve traditional proceedures so that use of ERTS-type data will become routine within the various state agencies most directly concerned. Cooperating agencies are the Office of Earth Resources, Division of Commercial and Sports Fisheries, State Planning Division, Office of Water and Air Resources, and additionally, the Water Resources Research Institute of the University of North Carolina.

TITLE: APPLICATION OF ERTS-A IMAGERY TO FRACTURE-RELATED MINE SAFETY HAZARDS IN THE COAL MINING INDUSTRY (MMC#325)

PRINCIPAL INVESTIGATOR:

Dr. C. E. Wier
Indiana Geological Survey
611 N. Walnut Grove
Bloomington, Indiana 47401

SUMMARY: This experiment will utilize ERTS-A imagery for developing fracture information that can be utilized to reduce coal mining hazards both from roof falls in underground mines and blow-outs and rock falls in strip mining. The test area is the coal producing district of southwestern Indiana. Two test sites were chosen for detailed studies--Pike County, containing mostly thin residual soils over bedrock, and Sullivan County containing thick unconsolidated deposits of glacial origin over bedrock. Both test sites contain large areas of abandoned underground mines and of active and abandoned strip mines. Fractures in the roof rock of underground coal mines are a primary contributor to roof falls. More than half of the fatalities that occur in underground mines each year in the United States are caused by roof falls. Using ERTS-A imagery and complementary aircraft imagery, lineaments will be detected, analyzed, and related to fractures in the underlying bedrock. Fracture swarms will be related to poor roof conditions in known underground mines. This information will then be utilized to predict areas of both good and bad roof conditions as related to density and kinds of fractures in the rocks. Similarly, information on fractures will be related to weaknesses in the overburden material in strip mines.

DISCIPLINE: GEOLOGY

TITLE: SATELLITE GEOLOGICAL AND GEOPHYSICAL REMOTE SENSING OF ICELAND (SR 9651)

PRINCIPAL INVESTIGATOR:

Richard S. Williams, Jr.
U.S. Geological Survey
EROS Program Office
Washington, D. C. 20242

SUMMARY: RBV imagery from the ERTS-A satellite will be used to study a variety of geologic, hydrologic, oceanographic, and agricultural phenomena in Iceland - scientific work of a purely research interest and of a highly practical value and use. The RBV imagery will enable certain studies to be pursued which were impossible prior to the availability of such synoptic and repetitive data.

Ten separate interdisciplinary problems will be addressed in this study: 5 from the discipline of geology, 3 from hydrology, 1 from oceanography, and 1 from agriculture. The geologic studies are as follows: I - geothermal, II - volcano eruptive products, III - structural geology, IV - volcanic geomorphology, and V - marine geology. The hydrological experiments are: VI - ephemeral snow and ice, VII - glaciological features, and VIII - annual run-off and floods of rivers. The oceanographic study is: IX - sea ice. The agricultural experiment is: X - grasslands and forests. All of the experiments involve the mapping - from RBV imagery - of specific environmental phenomena such as glaciers, sea ice, lava flows, snow melt patterns (geothermal and volcanic), floods, grasslands, etc.

Success with these ten experiments in Iceland will be of value to Iceland and, by extention of similar techniques and findings, to other areas of the world as well. Iceland has perhaps the greatest variety of dynamic geologic and other environmental phenomena in a small area (about the same size as the Commonwealth of Virginia) than any other part of the Earth's surface. It represents a superb "test site" for the variety of experiments to be pursued and will make a large contribution to proving the efficacy of the ERTS-A satellite to record environmental phenomena for fundamental and applied research purposes.

TITLE: TO MAP THE DISTRIBUTION OF GLACIOFLUVIAL DEPOSITS AND ASSOCIATED GLACIAL LANDFORMS

PRINCIPAL INVESTIGATOR:

Raymond G. Woodman
Maine State Highway Dept.
Box 1208
Bangor, Maine 04401

TITLE: FACILITATING THE EXPLOITATION OF ERTS-IMAGERY USING SNOW ENHANCEMENT TECHNIQUES (MMC # 141)

PRINCIPAL INVESTIGATOR:

Dr. Frank J. Wobber
Earth Satellite Corporation
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Washington, D.C. 20036

SUMMARY: This experiment is designed to evaluate and utilize snow enhancement as a photogeological technique and to define its geological applications. Historically, lithological and structural data have been collected during snow-free periods on the assumption that snow cover obscures geological detail. Experience gained from analysis of orbital photography, however, suggests that snow cover and probably the monitoring of progressive snow cover changes (snow melting) using repetitive ERTS-A imagery can increase the utilization of low resolution (small scale) imagery. It is anticipated that snow enhancement, as a technique, may prove valuable for accentuating subtle fracture traces or drainage patterns useful in lithologic discrimination. The principal test sites for the experiment are located in western Massachusetts and Connecticut. The analysis will utilize both MSS and RBV imagery. Repetitive ERTS-1 imagery provides an opportunity to compare geological data yield during snow-covered versus snow-free periods. Snow depth data will be acquired throughout the winter to assess the influence of snow depth on the yield of geological information. Snow enhancement techniques may eventually prove valuable in the seasonal extension of geological studies to northern latitudes and particularly in areas of permanent snow cover.

## V. HYDROLOGY/WATER RESOURCES

TITLE: ESTIMATE OF QUANTITY, QUALITY AND DISTRIBUTION OF GROUND WATER

PRINCIPAL INVESTIGATOR:

Alberto Osejo Alvarez
Ingeominas
Carrera 30, No.51-59
Bogota, Colombia

TITLE: HYDROGEOLOGICAL INVESTIGATIONS IN THE PAMPA OF ARGENTINA

PRINCIPAL INVESTIGATOR:

Dr. Dieter Bannert
Geological Survey of F.R.G.
3 Hannover Germany

TITLE: EVALUATE THE APPLICATION OF ERTS-A DATA FOR DETECTING AND MAPPING SNOW COVER (SR NO. 201)

PRINCIPAL INVESTIGATOR:

James C. Barnes
Environmental Research & Technology, Inc.
429 Marrett Road
Lexington, Massachusetts 02173

SUMMARY: The purpose of this investigation is to evaluate the application of imagery from the

ERTS-A RBV and MSS sensors for snow survey. The objectives are: to determine the spectral interval most suitable for snow detection and mapping; to determine the accuracy with which snow lines can be mapped in comparison with the accuracies attainable from other types of measurements; and to develop interpretive techniques, such as to differentiate reliably between snow and clouds, to attain accurate geographic referencing, and to understand the effects of terrain and forest cover on snow detection. The ERTS imagery is being correlated with standard snow measurements, aerial-survey snow charts, and aerial photography for both mountainous and flat terrain within the United States. The three primary geographic areas are: the southern Sierra Nevada in California, the Upper Columbia Basin in northern Idaho and northwestern Montana, and the Salt River Project Area in Arizona; in each of these areas mountain snow cover is of significant hydrologic importance. Measurements for flat terrain are in the Upper Mississippi-Missouri River Basins region. The results of this investigation will demonstrate the advantages and limitations of spacecraft high-resolution, multispectral measurements for snow survey and will provide the analyst with interpretive techniques that will enable the maximum use of data from ERTS and future spacecraft systems.

TITLE: USE OF SPACE DATE IN WATERSHED HYDROLOGY

PRINCIPAL INVESTIGATOR:

Bruce J. Blanchard
U. S. Department of Agriculture

SUMMARY: The experiment is designed to develop a method of predicting appropriate coefficients for runoff equations when applied to agricultural watersheds. Coefficients have been derived for two commonly used runoff equations from historical data on 10 highly instrumented watersheds. Linear combinations of the mean spectral response in the four bands of ERTS-1 MSS data will be examined to determine the feasibility of measuring watershed response to rainfall. Hopefully, it may be possible to determine the best combination and the best season of the year to predict the appropriate coefficient in each runoff equation. The most promising spectral mean or linear combinations of the means will be tested by predicting the coefficients for a second set of 10 watersheds with extensive records. The predicted coefficients for the test watersheds will be compared to a set calculated from past runoff records. Using the techniques developed in this experiment, we hope to replace a system presently used by the Soil Conservation Service that is highly dependent on the judgment of the hydrologist and requires excessive computational time.

TITLE: APPLICATION FOR USE OF ERTS-A FOR RETRANSMISSION OF WATER RESOURCES DATA

PRINCIPAL INVESTIGATOR:

P.I. Campbell
Water Survey of Canada
Inland Waters Branch
Sir Charles Tupper Bldg.
Ottawa, Ont. Kia OH3, Canada

TITLE: DETECTION OF BREAK-UP CHARACTERISTICS OF ALASKAN WATERSHEDS

PRINCIPAL INVESTIGATORS:

Dr. Robert F. Carlson
Institute of Water Resources
and
Dr. Gerd Wendler
Geophysical Institute
University of Alaska
Fairbanks, Alaska

SUMMARY: The project will evaluate the usefulness of ERTS data for monitoring the progression of break-up in Alaskan watersheds. Special attention will be given to evaluation of ERTS data as a tool in operational prediction of snowmelt runoff. Attention will also be paid to the characterization of the natural break-up pattern in the watershed and to relate observed break-up rates to quasi permanent physiographic features such as slope, aspect and the nature of the surface and to the transient environmental factors such as wind, radiation balance and temperature. Each set of ERTS data will be used to detect the areal extent of snow cover in three states - non-melting snow cover, melting snow cover and no snow cover. Distinction between snow cover and no snow cover will be made by albedo determination and the distinction between melting snow and non-melting snow will be accomplished by computer analysis of the ratios of the four visible bands of the satellite. The satellite observations and analysis will be compared with ground truth measurements collected at two sites near Fairbanks, Alaska - the Caribou-Poker Creek Research Watershed and the Chena River Basin.

TITLE: THE USE OF ERTS IMAGERY IN RESERVOIR MANAGEMENT AND OPERATION (MMC #89)

CO-PRINCIPAL INVESTIGATORS:

Mr. Saul Cooper
New England Division, Corps of Engineers

Dr. Paul Bock
The University of Connecticut

SUMMARY: The primary aim of our studies is to evaluate the possible future usefulness of satellites such as ERTS-1 in the day to day operation of Corps of Engineers water resource projects.

ERTS-1 will relay hydrologic and water quality data from 25 data collection platforms located all over New England to the Corps New England Division, Reservoir Control Center in "near real-time" with the aid of a direct hard-line link from NASA's Goddard Spaceflight Center. An estimate of the cost of establishing and operating such a network Corps-wide, but with the assumed existence of direct satellite relay of data to Corps facilities, will be made and compared to conventional telephone, telegraph and ground based radio relay methods.

ERTS-1 imagery will be analyzed to determine to what extent it can supplement present data sources by providing an overall view of ground conditions. Imagery studies and measurements will be made of fluctuations in river, lake and reservoir stages as well as icing of water surfaces, location and possibly depth of snow cover, moisture content of the soil and water quality parameters.

Personnel from the Corps of Engineers Cold Regions Research and Engineering Laboratory (CRREL), Hanover, New Hampshire are cooperating with us in these studies, especially those associated with soil moisture.

TITLE: FLOOD PLAIN MAPPING AND EVALUATION

PRINCIPAL INVESTIGATOR:

Warren E. Grabau
U.S. Army Engineer
Waterways Exp. Station
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Vicksburg, Miss. 39180

TITLE: EVALUATION OF SPACE-RELAYED HYDROLOGIC DATA IN SOUTH FLORIDA (WATER MANAGEMENT MODEL) (SR 272)

PRINCIPAL INVESTIGATOR:

Aaron C. Higer
U. S. Geological Survey
Water Resources Division
Federal Bldg., Rm. 730
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Miami, Florida 33130

SUMMARY: Water Supply for the east coast of South Florida, with a population of 2 1/4 million, depends upon the retention of water in four major impoundment areas. Owing to the flat terrain in the water conservation areas, the shallow depths (1 to 3 feet), the large area (1,400 square miles), the abundance of vegetation, the amounts of water in surface storage have not been accurately determined.

DCP's will supply water level and rainfall data from index areas within the impoundments. The results can be used immediately for water management purposes and correlated with concurrent multispectral TV camera and scanner projections. These projections will be evaluated to delineate the areal extent of fresh water inundation. Thematic images will be produced from a water management computer model of the hydrologic system. After the proposed stage-storage relations have been developed they will be forwarded directly to the water managers in the Central and Southern Florida Flood Control District in West Palm Beach, Florida.

TITLE: HYDROLOGIC INDICES TEST USE OF DYNAMIC BASIN CHARACTERISTICS EXTRACTED FROM ERTS DATA FOR IMPROVING REGRESSION ESTIMATES OF STREAMFLOW CHARACTERISTICS (SR 342-F)

PRINCIPAL INVESTIGATOR:

Este F. Hollyday
U. S. Geological Survey
Water Resources Division
Federal Office Bldg., Rm. 144
Nashville, Tennessee 37203

SUMMARY: Uniform measurements of dynamic basin characteristics are needed for the analysis of streamflow records collected at gaging stations and for the regionalization of these records to ungaged sites. Change in the relative area of infrared-reflective vegetation, standing water, snow, and massed works of man in twenty drainage basins in the Chesapeake Bay area will be measured repetitively using time-sequential sets of ERTS-A data covering a full water year. Indices derived from time-lapse data processing of these four themes will be tested for hydrologic significance in regressions with streamflow characteristics determined from 600 station-years of record. Standard errors from regressions using space-acquired data will be compared with standard

errors from regressions employing conventionally-acquired data. A reduction in standard errors would improve regionalization of streamflow data and would introduce a new technique permitting the streamlining and optimization of the U. S. Geological Survey streamflow data program.

TITLE: WATER RESOURCE MONITORING PLATFORM

PRINCIPAL INVESTIGATOR:

Dr. Jaan Kruus
Dept. of Fisheries and Forestry
No. 8 Temporary Building
Carling Avenue
Ottawa, Canada

TITLE: ANALYSIS AND APPLICATION OF ERTS DATA TO WATER RESOURCES RESEARCH AND MANAGEMENT PROBLEMS ON THE GREAT LAKES

PRINCIPAL INVESTIGATOR:

DR. R. K. LANE
DR. K. P. B. THOMSON
CANADA CENTRE FOR INLAND WATERS
BURLINGTON, ONTARIO
CANADA

SUMMARY: The presence and movements of thermal features and substances in large lakes is of direct concern to water research and management agencies. Normally, these (thermal effluents, turbid river effluents, oil slicks, algae blooms, for examples) are identified through ship survey programs. It is anticipated that the large scale features on the Great Lakes will be identifiable in ERTS data and that they can be interpreted in terms of the size, shape and movement of water masses and gross biological parameters, in each of Lakes Ontario, Erie, Huron and Superior. Further, it is anticipated that large scale dynamic phenomena, which must be understood if improvements in lake modeling efforts are to be made, may be inferred from turbidity patterns in these large lakes (e.g. upwelling, dispersion of large river effluents, etc.). Ship surveys are expensive and only quasi-synoptic. They have the advantage that they can provide high quality data for all depths. Nevertheless, many large scale lake features can be inferred from the surface data alone, and space acquired data may, in the future, reduce the frequency of ship surveys, particularly in relatively remote regions. The 1972 programs will provide a unique opportunity to evaluate ERTS data in comparison with large quantities of ground truth (in Lake Ontario). Limited, but acceptable ground truth for the other lakes is expected from the CCIW monitor survey program.

TITLE: EVALUATE ERTS IMAGERY FOR MAPPING AND DETECTION OF SNOW COVER ON LAND AND ON GLACIERS (# 342-7)

PRINCIPAL INVESTIGATOR:

Dr. Mark F. Meier
Water Resources Division
U.S. Geological Survey
1305 Tacoma Avenue South
Tacoma, Washington 98402

SUMMARY: Images from the ERTS RBV and MSS sensors will be evaluated for obtaining data on spatial and temporal changes of snowlines and glacier equilibrium lines within the Pacific Mountain System from Washington to central Alaska. These data will be related to synoptic meteorological data to gain a better understanding of snowpack growth and decay over large areas. Twice during the melt season, regional maps of snow distribution will be produced to determine latitudinal variations of snowpack from temperate to arctic environments. More detailed time-sequence image analysis of six local sites will be made utilizing the Stanford Research Institute Cloud Console. Further studies will include attempts to measure glacier Accumulation Area Ratios (AAR), snowline altitudes, precipitation shadow effects, and glacier surges.

TITLE : "SNOW SURVEYING TO ASSES RISK OF SPRING FLOOD AND TO EVALUATE SNOW STORAGE IN CATCHMENT AREAS OF HYDRO-POWER STATIONS"

PRIME INVESTIGATOR :

CIVIL ENGINEER H. ODEGAARD
STATE POWER BOARD
P.O. BOX 5091
OSLO 3, NORWAY

SUMMARY : The two objectives of this experiment are to improve the existing flood warning system of the river Glomma, the greatest in Scandinavia (42000 $km^2$ catchment area), and to give a better basis for the operation of hydro-power reservoirs. Measurements made in the upper reaches of the river are used to predict stages and discharge in the densely populated areas at the lower reaches 3-5 days later by using computer and multiple linear regression. ERTS-I images will greatly enhance the possiblilties of getting new and, up to now, un available data on the snow cover in remote areas and thereby increasing the accuracy and reliability of our flood warning system. The ERTS-I images will be interpreted by conventional air photo techniques, but also with the intention of exploiting the advantages that multispectral photography offers in this spesific area. ERTS-I data will be combined with those from the aprox. 800 snow sampling stations in Southern Norway, and the data from measurements from radiometric air surveying of ground gamma radiation which is now a routine operation for determination of the water eqvivalent of snow in mountainious areas. ERTS-I images covering Norway South of 67°N will be used.

TITLE: EVALUATE GLACIER MASS BALANCE BY VARIATIONS IN TRANSIENT SNOW-LINE POSITIONS

PRINCIPAL INVESTIGATOR:

Dr. Gunnar Ostrem
Norwegian Water Res. and Elec. Bd.
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Oslo 3, Norway

TITLE: NEAR REAL-TIME WATER RESOURCES DATA FOR RIVER BASIN MANAGEMENT

PRINCIPAL INVESTIGATOR:

Richard W. Paulson
U. S. Geological Survey
Water Resources Division
Harrisburg, Pennsylvania 17108

SUMMARY: The objective of this experiment is to determine the utility of Return Beam Vidicon (RBV) and Multispectral Scanner (MSS) imagery and hydrologic data relayed by the Data Collection System (DCS) for river basin management. The experiment will be carried out in the Delaware River Basin by the Pennsylvania District, Water Resources Division, U. S. Geological Survey, in cooperation with staff of the Delaware River Basin Commission.

Data Collection Platforms will be placed on twenty USGS water resources stations in the basin and ERTS will be used to relay hydrologic data from the basin to NASA's Goddard Space Flight Center. The hydrologic data will be forwarded by landline to the USGS Current Records Center in Philadelphia for processing and dissemination to Delaware River Basin water resources officials. These data will be used for RBV and MSS image interpretation and also will be compared to landline telemetered hydrologic data, which will be available from a few of the twenty stations, to determine the efficiency and precision of DCS data.

These DCS data and imagery will provide information on water quality, streamflow, ground water availability, flood and coastal storm damage, circulation patterns, sources of sediment, wetlands, and other hydrologic phenomena.

TITLE: USE OF DCS TO OPERATE A NETWORK OF REMOTE HYDROLOGICAL AND CLIMATOLOGICAL STATIONS

PRINCIPAL INVESTIGATOR:

Raymond Perrier
Dept. of Natural Resources
Meteorological Service
1640 Boulevard De L'entente
Quebec 6, P.Q., Canada

TITLE: DYNAMICS OF SEDIMENT PLUMES IN LAKE ONTARIO (SR 342-D)

PRINCIPAL INVESTIGATOR:

Edward J. Pluhowski
U. S. Geological Survey
Water Resources Division
Washington, D. C. 20242

SUMMARY: This investigation focuses on the turbidity and suspended solid plumes generated by the Niagara, Genesee, and Oswego rivers. A major objective is to define the dynamics of each plume under a variety of river discharges and wind stresses. Photography from the satellite will be used to evaluate the areal extent and intensity of each plume. Ground truth during selected overpasses will consist of sampling for turbidity and measurements of water temperature as well as wind speed and direction. Time-lapse photography techniques developed by the Stanford Research Institute are to be used as a tool to assess both the seasonal and short-term perturbations of each plume. Additionally, green-band photography should be useful in revealing bottom topography in the vicinity of each plume. If successful, bathymetry obtained from the satellite can be useful in delineating areas of sediment deposition in the quiescent lake waters.

TITLE: AN ERTS PROGRAM FOR THE INTERNATIONAL FIELD YEAR FOR THE GREAT LAKES (IFYGL)

PRINCIPAL INVESTIGATOR:

Fabian C. Polcyn
Environmental Research Institute of Michigan
(Formerly Willow Run Laboratories, The University of Michigan)
Ann Arbor, Michigan 48107

SUMMARY: The International Field Year for the Great Lakes (IFYGL) is a synoptic study of Lake Ontario and its Basin during April 1972 to March 1973. Supporting numerous ship- and land-based experiments of investigators from Canadian and American agencies and universities is a comprehensive program to process and analyze ERTS-MSS data from Lake Ontario. Coupled with the ERTS analysis effort is the collection and analysis of complementary multispectral and photographic data obtained from ERIM's multispectral research aircraft. Specific objectives of this program are twofold: 1) to study the water balance relationships for land portions of the Basin and 2) to study the physical limnology of the lake system. The approach is to process MSS data to extract spectral signatures for features and conditions of interest (landforms, soils, vegetation, surface water, sediment plumes, pollution, and circulation

patterns). These signatures will be studied and used to map the distribution of the features of hydrologic interest. Quantitative results of this investigation are expected to contribute to our understanding of the dynamics of a large lake system (an ocean in miniature) and extend the studies of individual researchers in the field to basin-size areas. Both analog and digital processing techniques will be utilized.

TITLE: Applications of Remote Sensing to the Surveillance of Lake Ice (MMC #072)

PRINCIPAL INVESTIGATOR:
Dr. Leonard J. Porcello

PROJECT SCIENTIST:
Dr. M. Leonard Bryan
Willow Run Laboratories
University of Michigan
Ann Arbor, Michigan 48107

SUMMARY: This experiment is designed to study the applicability of remote sensing techniques to the determination of types and distribution of freshwater lake ice. Additional goals include the study of remotely measurable parameters of snow, snow packs and ice, and the evaluation of the utility of a broad multispectral approach to the problem. Data from ERTS-A will be augmented by airborne radar imagery generated at wavelengths of 3 cm and 26 cm and, to the extent feasible, by airborne multispectral scanner data. Observation sites include both large lakes (eastern Lake Superior, northern Lake Michigan) and small lakes (Douglas Lake, Michigan). Aircraft sensor and ground truth data, the latter providing point calibration, will be collected during early 1973 through the cooperation of NASA and NOAA. The results of this study are expected to lead to more accurate identification of ice and snow conditions for transportation (e.g., lake shipping) planning as well as for hydrological considerations in snow melt and snow moisture balance problems.

TITLE: ERTS DATA COLLECTION SYSTEM INSTRUMENTATION MANAGEMENT AND DEVELOPMENT

PRINCIPAL INVESTIGATOR:

Duane M. Preble
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Gulf Coast Hydroscience Center
Bay St. Louis, Mississippi 39520

SUMMARY: The objective of this experiment is to provide instrumentation and hardware support to other data collection system (DCS) experimenters within the Department of Interior. The approach will be to (1) stock and supply data collection platforms (DCP) and necessary ancillary supplies, (2) provide repair services, (3) interface the DCP with existing hydrologic and geologic instrumentation, and (4) develop instrumentation to enhance DCS capabilities. An example of (4) is the Sequential Difference Storage Unit which will allow one parameter to be completely described between the periodic 12-hour transmission of 64 or 128 bits. Hydrologic parameters which the DCS will be utilized to transmit are water stage, precipitation, water quality (temperature, conductivity, pH, dissolved oxygen, etc.), snowfall, and wind speed and direction. Geologic parameters which the DCS will be utilized to transmit are geothermal temperatures, tilt, and seismic event counters.

TITLE: APPLICATIONS OF ERTS DATA COLLECTION SYSTEM (DCS) IN THE ARIZONA REGIONAL ECOLOGICAL TEST SITE (SR 184)

PRINCIPAL INVESTIGATOR:

Herbert H. Schumann
U. S. Geological Survey
Water Resources Division
Federal Bldg., Rm. 5017
230 North First Avenue
Phoenix, Arizona 85025

SUMMARY: The principal objectives of the Arizona Regional Ecological Test Site (ARETS) project, covering 33,000 square miles of southern Arizona, are to test and evaluate remote sensor methods to environmental and earth resources problems. This investigation will utilize the ERTS Data Collection System (DCS) to provide a continual flow from six (6) ground-data platforms to aid in the evaluation of air and spaceborne imagery. The DCS will also be used to relay near real-time data on hydrologic parameters measured at key remote locations that reflect moisture conditions over large areas to aid in making water management decisions.

The extensive ground truth collection programs that will be in progress in southern Arizona during ERTS-A image orbits create a need to be able to access the ground conditions prior to the over-

flights. Some of the ERTS platforms will be used to relay data on solar radiation, precipitation, and air and soil temperatures that will reflect spatial variations in moisture conditions within the ERTS images. The continuous flow of the data will provide information on temporal changes between successive images.

The DCS platforms will be used to relay data on stream stage, precipitation, and snow-water content at key remote and relatively inaccessible locations to be used by water management agencies for making operational decisions concerning multiple-use reservoirs in central Arizona that develop hydroelectric power and supply water for municipal, industrial, and agricultural use in the Salt River Valley. Timely repetitive remote sensing from aircraft and satellites, together with the telemetry of ground sensor data collected at key locations, will provide valuable information to aid in the better management of land and water resources of this arid region.

TITLE: TIME-LAPSE DATA PROCESSING FOR DYNAMIC HYDROLOGIC CONDITIONS

PRINCIPAL INVESTIGATOR:

Sidney M. Serebreny
Stanford Research Institute
333 Ravenswood Ave.
Menlo Park, Calif. 94025

TITLE: DETERMINE THE UTILITY OF ERTS-A IMAGERY IN THE PREPARATION OF HYDROLOGIC ATLASES OF ARID LAND WATERSHEDS (SR 234)

PRINCIPAL INVESTIGATOR:

Lynn M. Shown
U. S. Geological Survey
Water Resources Division
Denver Federal Center
Denver, Colorado 80225

SUMMARY: The primary objective of the investigation is to determine the utility of ERTS-A imagery for: (1) delineating watershed divides and obtaining the size and shape of natural watershed areas that are larger than 10 square miles, (2) delineating vegetation type boundaries within these watersheds and estimating the areas of types that cover more than about 2 square miles, (3) estimating the portions of the watersheds that are bottom-land, gently sloping uplands, and steep uplands.

Another objective is to synoptically compare the geology, climate, vegetation, relief, drainage density, shape, and use of four widely separated, large, arid to semiarid watersheds.

The test sites are: the 500 square mile Willow Creek watershed in northeastern Montana, the 2,300 square mile Upper Rio Puerco watershed in northwestern New Mexico, the 2,200 square mile eastern Wind River Basin in central Wyoming and the 1,200 square mile Browns and Saleratus Wash watersheds in east-central Utah.

The basic approach will be to use photo interpretation to determine if known topographic features can be discerned on photographic transparencies of ERTS-A images. Positive identification of features will be established by comparing them to existing ground truth which will be delineated on 1:100,000 scale aerial photography of the watersheds.

TITLE: RELATIONSHIP BETWEEN SNOW COVER AND DISCHARGE AND WATER QUALITY OF WATERSHEDS

PRINCIPAL INVESTIGATOR:

Rene Tavernier
Geological Inst.
State University
Rozier 44
B-9000 Ghent, Belgium

TITLE: WATER POLLUTION MONITORING

PRINCIPAL INVESTIGATOR:

C. T. Wezernak, Ph. D.
Environmental Research Institute of Michigan
Post Office Box 618
Ann Arbor, Michigan 48107

SUMMARY: The objective of the investigation is to utilize ERTS data in the study of selected large scale water quality management problems. Included in the program are the following:

1. Study of effluent fields from selected major ocean outfalls in S. California and S. Florida
2. Barge dumping of wastes in the New York Bight
3. Suspended solids variation and spectral anomalies in Tampa Bay
4. Suspended solids variation and spectral anomalies in Lake Michigan and Lake Erie.

Photographic and scanner imagery from aircraft flights, ground truth, and other ongoing programs will be used to supplement and evaluate the ERTS data. The MSS data will be processed to map the spatial distribution of the observables. The results of this investigation are expected to contribute to the water quality management effort at each of the above locations.

TITLE: EVALUATION OF ERTS DATA FOR CERTAIN HYDROLOGICAL USES

PRINCIPAL INVESTIGATOR:

Mr. Donald R. Wiesnet
U.S. Dept. of Commerce, NOAA/NESS
Suite 300, 3737 Branch Avenue
Hillcrest Heights, Maryland 20031

SUMMARY:

This experiment has two distinct parts: One part deals with the melting snowpack in certain Sierra Nevada basins; the other part is a study of snowmelt and soil moisture in portions of the Lake Ontario basin. The Sierra Nevada snowpack provides much of the water for the populated regions of California. Accurate mapping of the Sierra is a necessary requirement for precise determination of the expected spring runoff. ERTS 1 imagery provides high resolution multispectral images that will permit better snowline definition and better cloud and vegetation discrimination than previously attainable from environmental satellites. In addition, ground truth from the highly instrumented American and Feather River Basins will be combined with ERTS information to assess the feasibility of indirect semiquantitative assessments of water storage in reservoirs.

Secondly, the International Field Year on the Great Lakes (IFYGL) is providing an intensive study of the Lake Ontario drainage basin during 1972-1973. The evaluation of ERTS data with respect to lake meteorology, energy balance, terrestrial water balance and water movement, will be facilitated by this extensive ground truth support. In particular, MSS imagery from ERTS should result in enhanced capability for snow mapping, including better discrimination between snow and clouds, snow and vegetation, and snow and ice. Very High Resolution Radiometer (VHRR) from ITOS D will provide thermal information of a resolution close to ERTS to enable mapping of snow, ice, water and soil temperatures.

TITLE: MONITORING THE WATER FLOW REGIME OF THE OKAVANGO SWAMPS.

PRINCIPAL INVESTIGATOR:

B.H. WILSON
DEPARTMENT OF WATER AFFAIRS
PRIVATE BAG 29
GABORONE, BOTSWANA.

SUMMARY: The Okavango Swamps in N.W. Botswana are of especial importance in that they comprise the largest inland surface water feature of this arid country. The water supply fluctuates seasonally and the flood pattern is still difficult to predict despite an intensive joint study by F.A.O. and the Botswana Government begun in June, 1968. Orapa, the diamond mine which has very recently become Botswana's biggest source of revenue, receives its water supplies from the Okavango. Obviously, ERTS photographs will reveal monthly variations of water flow in the Swamps and will assist in the prediction of flooding and planning of water supplies not only to Orapa, but also, possibly, irrigation schemes further east. The ecological implications of exploiting the water supply in the Swamps must also be considered as the area is rich in wildlife and an important tourist attraction. Mapping of the area at a scale of 1/50,000 was conducted by the Directorate of Overseas Surveys in 1969/70. Visual interpretation of ERTS imagery will attempt to correlate the tone values in the photographs with limits of flooding which can be easily determined in the field.

TITLE : STUDY OF MONITORING FRESH WATER RESOURCES

PRINCIPAL INVESTIGATOR :

Dr. H. L. Yarger
State Geological Survey
University of Kansas
Lawrence, Kansas 66044

SUMMARY : The purpose of this study if to determine the feasibility of satellite monitoring of reservoirs in Kansas. The ultimate goal is to help optimize reservoir management for use in flood control, agriculture, urban areas, and recreation. Two reservoirs, Perry and Tuttle Creek, will be sampled during every satellite pass. Imagery from the remaining 17 major reservoirs in Kansas will be examined. A subset of these which possess distinct gray level patterns will be sampled later in the year. The first task will be to develop a quantitative correlation between gray level and turbidity patterns. If this is successful, then an attempt will be made to distinquish between organic and inorganic suspended solids. Bulk 9.5 inch positive transparencies and bulk digital tape from the four MSS bands will be used. The Image Discrimination Enhancement Combination System (IDECS) located at the University of Kansas will be used for part of the analysis.

VI. INTERPRETIVE TECHNIQUES DEVELOPMENT

TITLE: IDENTIFICATION, DEFINITION AND MAPPING OF TERRESTRIAL ECOSYSTEMS IN INTERIOR

PRINCIPAL INVESTIGATOR:

Dr. James H. Anderson
Institute of Arctic Biology
University of Alaska
Fairbanks, Alaska 99701

TITLE: PROPOSAL FOR INVESTIGATION USING DATA FROM ERTS-A

PRINCIPAL INVESTIGATOR:

James D. Altenstadter
Cochise Co. Planning Director
P.O. Drawer AC
Bisbee, Arizona 85603

TITLE: STUDY OF NATURAL RESOURCES OF THE STATE OF CHIAPAS

PRINCIPAL INVESTIGATOR:

Anguiana Silvino Aguilar
Dept. of Agri. and Livestock
Bur. of Geography and Meteorology
Tacubaya, D.F., Mexico

TITLE: ANALYSIS OF EARTH RESOURSES AND FACTORS GOVERNING ENVIRONMENTAL QUALITY IN THE AMAZON REGION

PRINCIPAL INVESTIGATOR:

Luiz Henrique Aguiar de Azevedo
PROJETO RADAM
Av. Portugal, 54 - Urca
Rio de Janeiro - Brazil

SUMMARY: Project Radam tackles both theoretical and immediate utilization in practice of data derived from ERTS. Geometric fidelity, resolution, color balance, mosaicking, enlargement capacity, together with features discrimination and pattern recognition, will be studied concomitantly with routine mapping under way.

Scoping the collection of basic information for programs aiming at the socio-economic development of northern Brazil and The Amazon, a reconnaissance type survey by SLAR complemented with multispectral and super wide angle cameras, television and radar altimeter provides data for interpretation on mineral, vegetal and soil resources themes, plotted on 1:250.000 semi controlled radar maps also produced.
ERTS data will be added to available ground samples analysis, low altitude photos and aereal checks, video tapes, multispectral and color I.R. photos besides radar stereo strips and mosaics.
Other studies, such as multisensor multiscale system optimization, climatology from satelites data and applications for non conventional mosaics are also to be held.

TITLE: COORD AND EST. OF CENTRAL FACILITIES AND SERVICES FOR UNIVERSITY OF ALASKA ERTS SURVEY OF ALASKAN ENVIRONMENT

PRINCIPAL INVESTIGATOR:

Albert E. Belon
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

TITLE: PRECISION PROCESSING OF ERTS IMAGES USING DIGITAL IMAGE PROCESSING TECHNIQUES

PRINCIPAL INVESTIGATOR:

Mr. Ralph Bernstein
IBM Corporation
Federal Systems Division
18100 Frederick Pike
Gaithersburg, Maryland 20760

SUMMARY: The objective of this investigation is to design and implement an all-digital-system capable of applying precision-grade (scene corrected) geometric and radiometric corrections to ERTS Return Beam Vidicon (RBV) and Multispectral Scanner (MSS) sensor data, and to fully annotate the processed images with alphanumeric data, geodetic grid information, and calibration data. The system will be used to experimentally correct selected ERTS images received from the NASA Data Processing Facility in the form of computer compatible tapes.

The techniques used involve positioning of the digital sensor data to achieve geometric correction and modifying the sensor data intensity to achieve radiometric correction. Key elements of the processing techniques include a high speed technique for ground control point detection and registration (Sequential Similarity Detection Algorithm) to determine image distortion, orientation, and location, and high speed methods for geometric correction (point shift algorithm) and radiometric correction (table of look-up). Performance data, such as accuracy, quality, and computer running times will be determined from the experimental results.

Scene information from four geographical areas is being used to evaluate the digital image processing results. These areas are the Chesapeake Bay area, Indiana farmland, Phoenix area, and Monterey area. These scenes provide a range of agricultural, urban, mountainous and near shore marine areas that should fully allow qualitative and quantitative evaluation of the processing techniques.

TITLE: ERTS-A IMAGERY INTERPRETATION TECHS. IN TENNESSEE VALLEY

PRINCIPAL INVESTIGATOR:

Dr. E. Robert Bodenheimer
University of Tennessee
Knoxville, Tenn. 37916

TITLE: EVALUATION OF POTENTIAL ERTS-A DATA FOR MINERAL EXPLORATION

PRINCIPAL INVESTIGATOR:

Dr. William A. Brewer
Earth Satellite Corp.
2150 Shattuck Ave.
Berkeley, California 94704

TITLE: OVERALL STUDY OF ORIZABA-VERACRUZ TEST AREA

PRINCIPAL INVESTIGATOR:

Ruiz Bulmaro Cabrera
Bureau of Research and Labs
Roads Div., Photogremmetry Br.
Mexico, D.F., Mexico

TITLE: LAND USE (WETLANDS CHARACTERIZATION) ATCHAFALAYA RIVER BASIN

PRINCIPAL INVESTIGATOR:

Dr. Robert H. Cartmill
Earth Resources Laboratory
Mississippi Test Facility
Bay St. Louis, MS 39520

SUMMARY: The test site is the lower portion of the Atchafalaya River Basin in Louisiana. This river is a major distributary of the Mississippi River. It has distinct high water (spring) and low water (fall) flow regimes. The high sediment load carried by the river is rapidly filling the lakes and coastal wetlands of the lower portion of the basin. This has caused rapid and profound change in the ecology of the area. The site has been under remote sensing surveillance by aircraft since October 1971. A major purpose of the study is to compare the classification of principal vegetation and water bodies obtained from satellite data with concurrent data gathered by aircraft. Main emphasis will be placed on using multispectral data with computerized pattern recognition programs. Specific items to be studied are:

(1) Evaluate techniques for monitoring accretion/erosion.
(2) Demonstrate techniques for location and classification of aquatic plants.
(3) Evaluate techniques for determination of water characteristics, e.g., turbidity, source, inlet-outlet conditions.
(4) Evaluate techniques for differentiating swamps from dry land areas by means of forest species identification.

TITLE: ASSESSMENT OF UTILITY AND ECONOMY OF ERTS DATA IN PLANNING AND DEVELOPMENT AND MANAGEMENT OF RESOURCES

PRINCIPAL INVESTIGATOR:

Dr. Pradisth Cheosakul
National Research Council
Bangkok, Thailand

TITLE: INTERDISCIPLINARY RESEARCH ON THE APPLICATIONS OF ERTS 1 DATA TO THE REGIONAL LAND USE PLANNING PROCESS.

PRINCIPAL INVESTIGATOR:

Dr. James L. Clapp
1204 Engineering Building
University of Wisconsin
Madison, Wisconsin 53706

SUMMARY: This project is concerned with the application of ERTS 1 satellite data to the regional land use planning and allocation process. Although the degree to which ERTS 1 imagery can satisfy regional land use planning needs is not known, it appears to offer the means by which present techniques can be improved. Efforts are being made to determine the efficiency of ERTS 1 data (of both natural and cultural resources) in comparisons with resource inventories conducted by conventional methods. Objectives of the research are:

1. Compare ERTS 1 imagery to specific types of natural and cultural data at varying scales and during different dates of the year.

2. Determine the usefulness of ERTS 1 data for regional land use planning and allocation decisions.

3. Assist the total Wisconsin community of government and private groups involved with aspects of regional planning by making recommendations as to the usefulness of satellite imagery to the types of land allocation decisions that can be made.

The investigation and documentation of the application of ERTS 1 imagery to the regional planning process consists of utilizing three representative geographical regions within the state of Wisconsin. The three locations represent: 1) a variety of natural and cultural resource data; 2) different regional planning problems facing Wisconsin; 3) varying scales of data; and 4) areas that have been intensively studied by the investigators of this project utilizing conventional means.

TITLE: DESIGN AND EVALUATION OF A COMPUTER-BASED SYSTEM TO MONITOR AND GENERALISE, BY AREAS, DATA FROM THE ERTS PRECISION IMAGERY TAPES. (MMC No. 035)

PRINCIPAL INVESTIGATOR:
Professor Keith M. Clayton,
School of Environmental Sciences,
University of East Anglia,
Norwich, NOR 88C, England.

SUMMARY: The aim of this research is to devise a system of generalising remotely sensed data for areas of the earth's surface at a scale appropriate to a world data gathering system. The size of these areas (called UTA - Unit Target Area) will be determined during the course of the research. A size of 50km x 50km has been chosen for initial trials. Successful generalisation will allow the identification of change over successive orbits, and may also be used for small-scale mapping of these changes. The test areas are two ERTS scenes, one over the central UK, and the other over the Sierra Nevada, California, USA. By computer search of the precision imagery tapes, grey scale histograms will be compiled for successive orbits, and these can be compared to detect change exceeding the noise of the system. With time it will be possible to recognise automatically common reasons for change, e.g. contrasts in cloud cover. Automatic identification of change will allow those orbits showing no change to be omitted from visual search of the imagery, and effort may be concentrated upon those scenes which show departures from earlier orbits. As a first stage in developing small-scale map output, cloud cover percentages will be computed from the grey scale histograms and mapped by the computer.

TITLE: AN INTEGRATED STUDY OF EARTH RESOURCES IN THE STATE OF CALIFORNIA USING ERTS-1 AND SUPPORTING AIRCRAFT DATA

PRINCIPAL INVESTIGATOR:
Robert N. Colwell, Associate Director, Space Sciences Laboratory, University of California

SUMMARY: Approximately 20 scientists from 5 campuses of the University of California (Berkeley, Davis, Santa Barbara, Los Angeles and Riverside) currently are engaged in this NASA-funded experiment. Among the potential uses of ERTS-1 and supporting aircraft data that are being investigated are those which would facilitate the analysis of: (1) land use and the factors which govern land use; (2) vegetation, both cultivated and wild; (3) water yield, both surface and subsurface; and (4) disasters, both actual and potential.

Studies which have been conducted to date under this integrated project have been limited primarily to the analysis of data acquired by ERTS-1 over portions of California in late July, 1972 during the first week after the vehicle had been launched. The analyses have been based on a study of not only the multiband images obtained during that period of time by both the Return Beam Vidicon and Multispectral Scanner systems but also of the computer-compatible magnetic tape records themselves, as obtained by the Multispectral Scanner. In addition, the analysts are seeking to determine the potential usefulness (in conjunction with the ERTS-1 data) of NASA-acquired high altitude aerial photography of selected portions of the California test site, consistent with the principles of multistage sampling.

Once the investigators have been supplied with sequential remote sensing data obtained at 18-day intervals by the aircraft and spacecraft, they will make a detailed study of the extent to which an inventory of various kinds of earth

resources in California can be facilitated by means of a comparative analysis of such sequential data. Based on previous studies which some of these scientists have made for NASA in Maricopa County, Arizona and in San Joaquin County, California, it is anticipated that the data-gathering multi-date capability of ERTS-1 will be fully as important as its multiband capability, and perhaps even more important in some specific instances, as in the identification and analysis of agricultural crops.

The University of California scientists involved in this integrated study are working closely with California's various resource management groups in such fields as forestry, hydrology, range management and agriculture in order to ensure that the analyses which are made are responsive to the expressed needs of the resource managers, themselves. The possibility is recognized of achieving two kinds of benefits from the study: (1) some of the ERTS-based resource inventories should prove to be of direct and immediate benefit operationally to the managers of California's earth resources, even though ERTS-1 was intended to serve only as an experimental system, and (2) resource inventory techniques developed and tested in California should prove to be applicable, with only minor modification, to many analogous areas in developing parts of the globe.

TITLE: FEASIBILITY STUDY FOR LOCATING ARCHAEOLOGICAL VILLAGE SITES BY SATELLITE REMOTE SENSING TECHNIQUES

PRINCIPAL INVESTIGATOR:

Dr. John P. Cook
C/O William J. Stringer
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

TITLE: STUDY COMPINING RES. AND USE OF ERTS-A SKYLAB AND SUPPORT. A/C DATA FOR MORE EFF. RESOURCE MGMT.

PRINCIPAL INVESTIGATOR:

Earl A. Davis
The Resources Agency
1416 9th St., Rm. 1311
Sacramento, Calif. 95814

TITLE: INVESTIGATION OR URBAN-REGIONAL PLANNING IN VENEZUELA

PRINCIPAL INVESTIGATOR:

Manuel J. Corao
Ministry of Public Works
427825 Caracas
Venezuela

TITLE: UTILIZATION OF ERTS-1 DATA IN THE HOUSTON AREA (ER-600)

PRINCIPAL INVESTIGATOR:

R. Bryan Erb, Manager
Applications Office, TF2
NASA Manned Spacecraft Center
Houston, Texas 77058

SUMMARY: The general objective of this investigation is to determine the individual and combined roles of ERTS spacecraft, aircraft, and ground data for their contributions to the definition and development of the technology needed for these systems to serve an integrated Earth Resources Survey Program.

The specific objectives are as follows:

- o Use the ERTS-1 imagery to determine land use categories by conventional photo-interpretation techniques.
- o Use digital data from the ERTS-1 systems to make land use classifications with automatic data processing (spectral pattern recognition) techniques.
- o Relate these findings to land use present at the time of the spacecraft overflights as determined from aircraft and ground data.
- o Assess the utility of the ERTS-1 data to detect, identify, locate and measure features of applications interest in forest, range, coastal and urban areas.
- o Conduct a data utilization experiment in cooperation with the U.S. Department of Agriculture (ASCS) to evaluate the utility of ERTS-1 and aircraft data to identify crop species, categories of land use, field boundaries and to estimate crop and land use acreages.

Test sites include an 18-county region on the Texas Gulf Coast and parts of 6 other counties selected by ASCS for the variety of crop types and land use conditions.

The results of this investigation are expected to be directly applicable to a variety of resource management and land use planning activities.

TITLE: EXPERIMENTAL CLASSIFICATION OF GROUND AREAS AND EXPLOITATION OF REPETITIVE MSS COVERAGE

PRINCIPAL INVESTIGATOR:

Dr. Andrew G. Favret
Director, Computer Center
Catholic University of America
Washington, D. C. 20017

SUMMARY: This task is being conducted in conjunction with a land use study (Dr. Priscilla Reining) of Haya country in Tanzania, west of Lake Victoria. Use will be made of digital tapes of MSS imagery to evaluate classification algorithms, particularly in conjunction with detection of patterns associated with native villages. Graphic display terminals will be used to provide man-machine interaction. A variety of image processing techniques will be investigated to improve registration over relatively small areas, thereby permitting greater exploitation of the repetitive coverage capability.

TITLE: MULTIDISCIPLINE STUDY OF EARTH RESOURCES OF AUSTRALIA, ANARCTICA, PAPUA AND NEW GUINEA

PRINCIPAL INVESTIGATOR:

Dr. N.H. Fisher
Bureau Mineral Resources
Canberra, A.C.T.
Australis

TITLE: OPTICAL AND DIGITAL INFORMATION EXTRACTION TECHNIQUES

PRINCIPAL INVESTIGATOR:

Dr. A. Fontanel
Geophysics Department
Institut Français du Pétrole
92 - Rueil-Malmaison, France

SUMMARY: From a general point of view, this proposal is concerned with the development of both optical and digital filtering techniques in order to facilitate the geological interpretation of the photographs. Our aim is particularly to improve the degree of resolution and to increase the contrast of recordings by deconvolution. We also plan to develop classification and identification techniques which will perhaps lead to semi-automatic mapping. A Control Data 7600 computer will be used for digital filtering. The optical processing will be performed with the aid of Prof. Françon, Institut d'Optique, Paris.

TITLE: EVALUATE THE UTILITY OF ERTS-A AND EREP FOR MAPPING AND DEVELOPING GREEK NATURAL RESOURCES

PRINCIPAL INVESTIGATOR:

John Gerakis
Hellenic Ind. Dev. Bank (ETBA)
El. Venizelou 18
Athens 135, Greece

TITLE: ERTS APPLICATION PROGRAM FOR LOWER MAGDALENA AND CASCA VALLEYS

PRINCIPAL INVESTIGATOR:

Dr. Alvaro Fletcher Gonzalez
C.I.A.F.
Apartado Nacional 762
Chapinero
Bogota, Columbia

TITLE: AUTOMATED THEMATIC MAPPING AND CHANGE DETECTION OF ERTS-A IMAGES (MMC # 074)

PRINCIPAL INVESTIGATOR:

Mr. Nicholas Gramenopoulos
Optical Systems Division
Itek Corporation
10 Maguire Road
Lexington, Massachusetts 02173

SUMMARY: This investigation is concerned with the development of automated interpretation techniques for the recognition and identification of earth resources. The resources will be identified by using both multispectral and spatial signatures. Ground truth data and aircraft underflight photography will be used to train the recognition algorithms. The data processed will be RBV and MSS images acquired by the ERTS-1 satellite, over six test sites located in the vicinities of: Phoenix, Arizona, Weslaco, Texas, Cascade Mountains, Washington, New Orleans, Louisiana, Salt Lake, Utah, and Salton Sea, California. The processed data will be thematic maps of resources consisting of annotated and outlined images. The seasonal changes of hydrologic and agricultural resources will also be identified. The results are expected to be applicable to a future automatic system of resource inventory and management.

DISCIPLINE: URBAN AND REGIONAL PLANNING

TITLE: URBAN AND REGIONAL PLANNING

PRINCIPAL INVESTIGATOR:

Mr. John W. Hannah
Brevard County Development Adm.
P. O. Box 1496
Titusville, Florida 32780

SUMMARY: The purpose of this experiment is to investigate possibilities for application of satellite remote sensing to regional planning problems and to develop techniques useful in such application. Visual and digital data for the six-county East Central Florida Region will be analyzed. The three major areas of investigation will be: (1) impact of Disney World development, (2) application to routine planning work and (3) development of digital methods of analysis. Collaboration of the Earth Resources Program at Kennedy Space Center is being provided in the form of related aircraft data, use of viewing and computing facilities and collaboration of computer personnel.

TITLE: USE OF FEATURE EXTRACTION TECHNIQUES FOR THE TEXTURE AND CONTEXT INFORMATION IN ERTS IMAGERY

PRINCIPAL INVESTIGATOR:

R.M. Haralick
Remote Sensing Laboratory
Center for Research, Inc.
University of Kansas
Lawrence, Kansas 66044

SUMMARY: Two fundamental pattern elements in the human interpretation of image data are texture and tone. The concept of tone is based upon the varying shades of grey of resolution cells in an image, while texture is concerned with the spatial distribution of grey tones. Most of the pattern recognition methods used to process remotely sensed image data have been mainly concerned with temporal and spectral characteristics on a resolution cell, while ignoring the textural and context type information. The main objective of our present work is to develop appropriate features for texture and context information and to use these features along with the spectral and temporal characteristics for pattern discrimination and pattern classification clustering on the ERTS imagery.

The texture context information in an image is contained in the average spatial relationship which the grey tones in the image have to one another. Hence, it is our conjecture that the texture context information is adequately specified by the matrix of relative frequencies P(i,j) with which two neighboring resolution cells of given separation and spatial relationship occur on the image, one with grey tone i and the other with grey tone j. These matrices are computed for different spatial relationship and different separation; for example, horizontally adjacent resolution cells, diagonally touching resolution cells and so on. From these spatial grey tone dependence matrices, we can extract features for describing the texture and context information in the image.

Two types of features are of interest. The first type of features are derived to provide information about the homogeneous or unhomogeneous tonal features of small areas on the image. These features provide information about the visual textural appearances of different land use categories. The second set of features are derived for large areas of the image and these features provide information about contexts in which the land use categories occur. Both these features combined with spectral and temporal information will be used as the basis for discrimination between different types of categories of interest to ERTS investigators at Kansas.

TITLE: ERTS DATA PROCESSING FACILITY AT THE UNIVERSITY OF KANSAS

PRINCIPAL INVESTIGATORS:

R.M. Haralick and G. L. Kelly
Remote Sensing Laboratory
Center for Research, Inc.
University of Kansas
Lawrence, Kansas 66044

SUMMARY: The main objective for the ERTS data processing facility is to provide the opportunity to use the digital and analog automatic processing available at the University of Kansas Remote Sensing Laboratory to all interested ERTS investigators. The University of Kansas has developed over past years a data processing facility consisting of near real time analog and digital machine called IDECS (Image Discrimination Enhancement Combination System) and a software programming package called KANDIDATS (Kansas Digital Image Data System) to process image data.

During the ERTS data analysis phases, quick look processing of the bulk 70 mm images will be provided by the IDECS. Processing using the IDECS will consist of congruencing the images, locating the training areas using the available ground truth, implementing a decision rule, and generating and displaying a land use map.

Processing using the KANDIDATS is considerably more complicated. Computer programs have been developed to convert the raw data provided by NASA to a standard computer format to register the images, to edit and pick out the regions of image that are of interest, to extract the texture context information in the images, and to quantize the data. Programs have also been developed for implementing various clustering or pattern discrimination techniques to produce land use maps printed in color on the digital printer. Other data products resulting from KANDIDATS processing include the digital printer black and white quantized ERTS images, scattergrams and histograms.

TITLE: APPLICATION OF ERTS(A) IMAGERY TO INVENTORYING LAND USE AND NATURAL RESOURCES

PRINCIPAL INVESTIGATOR:

Ernest E. Hardy
N.Y. State College of Agriculture
Cornell University
Ithaca, New York 14850

TITLE: TO DETECT AND IDENTIFY DEVELOPMENT OR CHANGES IN LAND USE PATTERNS FOR REGIONAL PLANNING PURPOSES

PRINCIPAL INVESTIGATOR:

William Harting
Tri State Regional Planning
100 Church Street
New York, N.Y. 10007

TITLE: PRELIMINARY STUDY OF LAKE PONTCHARTRAIN AND VICINTY USING REMOTELY SENSED DATA FROM ERTS

PRINCIPAL INVESTIGATOR:

Johy U. Hidalgo
Eng. Sciences Environ. Center
Tulane University
6823 St. Charles Ave.
New Orleans, La. 70118

TITLE: APPLICATIONS OF ERTS-A DATA TO RESOURCES MANAGEMENT OF THE LOWER MEKONG BASIN

PRINCIPAL INVESTIGATOR:

Dr. F. Homayounfar
The Plan Organization
Government of Iran
Tehran, Iran

TITLE: PROGRAM FOR THE LANDS ORIENTALES-COLOMBIA

PRINCIPAL INVESTIGATOR:

Dr. N. Bastiaan Koopmans
C.I.A.F.
Apartado National
762 Chapimero
Bogata, Colombia

TITLE: ESTABLISHMENT OF AN ERTS-A FILM LIBRARY IN TUCSON

PRINCIPAL INVESTIGATOR:

Dr. Larry K. Lepley
Arizona Regional Eco. Test Site
University of Arizona
Tucson, Arizona

TITLE: MULTIDISCIPLINARY STUDIES OF NATURAL RESOURCES

PRINCIPAL INVESTIGATOR:

D.R. Soula Liendo
Direccion General De
Fabricaciones Militares
Cabildo 65
Buenos Aires, Argentina

TITLE: IMAGE ENHANCEMENT AND ADVANCED INFORMATION EXTRACTION TECHNIQUES (MMC#136)

PRINCIPAL INVESTIGATORS:

Mr. William A. Malila
and Mr. Richard F. Nalepka
Environmental Research Institute
of Michigan
P.O. Box 618
Ann Arbor, Michigan 48107

SUMMARY: Experience has been gained over the past decade at ERIM (formerly the Willow Run Laboratories of The University of Michigan) in computer processing and the extraction of information from airborne multispectral scanner data and in modeling atmospheric effects in received radiance signals. The general objectives of this investigation are to adapt existing techniques for their application to ERTS-1 data, to assess the applicability of these techniques to satellite sensing by applying them to selected ERTS-1 data, and to identify any additional problems that might be associated with such processing of satellite multispectral scanner (MSS) data. Three aspects of remote sensing are being studied: (1) compensation for atmospheric effects in ERTS-1 data, (2) preprocessing and feature enhancement techniques for improved computer recognition performance, and (3) techniques for estimating proportions of unresolved objects in individual resolution elements of the ERTS-1 MSS. The primary test site for ERTS-1 data for the investigation is located in south central Michigan; however, the results of the investigation should have general applicability. Ground-based radiation measurements and simultaneous underflights by the Michigan multispectral scanner aircraft are being made to permit the correlation of satellite, aircraft, and ground data.

TITLE: PILOT STUDY TO PROVIDE ECONOMIC AND EFFECTIVE INFO SYS TO RESPOND PARIDLY TO NEEDS OF RES. AND ENVIRONMENT

PRINCIPAL INVESTIGATOR:

Dr. W. Morley
Dept. of Energy, Mines and Res.
Ottawa, Canada

TITLE: ERTS INFORMATION SYSTEM DEVELOPMENT FOR POTOMAC RIVER BASIN NATURAL RESOURCE MANAGEMENT

PRINCIPAL INVESTIGATOR:

Norman Macleod
American University
Mass. & Neb. Aves.,N.W.
Washington, D.C.

TITLE: QUANTITATIVE AND QUALITATIVE DISTRIBUTION PATTERN OF NATURAL RESOURCES

PRINCIPAL INVESTIGATOR:

Iwao Nakajima
Government Forest Experiment Station
5-37 Shimomeguro
Meguro-Ku
Tokyo, Japan

TITLE: ANALYSIS AND PROCESSING OF ERTS-A DATA TO OBTAIN INFORMATION ABOUT WATERFOWL HABITAT CONDITIONS

PRINCIPAL INVESTIGATOR:

Dr. Harvey K. Nelson
Department of the Interior
Bureau of Sport Fisheries and Wildlife
Northern Prairie Wildlife Research Center
Jamestown, North Dakota 58401

CO-INVESTIGATOR:

Mr. Edgar A. Work, Jr.
Environmental Research Institute of Michigan
P. O. Box 618
Ann Arbor, Michigan 48107

SUMMARY: Wildlife biologists have hypothesized that changes between May and July in the amount of surface water contained in waterfowl habitat could provide a useful index for predicting waterfowl breeding success. Such information is now obtained from aerial surveys on a routine basis and more recently automatic data processing of multispectral scanner data obtained from aircraft altitudes has shown promise for obtaining an index of habitat conditions. Similar data obtained from spacecraft will be used to extend survey coverage, provide more synoptic information, and free wildlife personnel for other work. In addition to the above, data reduction techniques are sought which will provide information on short and long term habitat changes which affect waterfowl. Primary phenomena being studied will be surface water with aircraft and satellite multispectral scanner imagery being used in a multistage sampling design.
Indices developed to show changes in surface waters will be used to predict fall waterfowl populations. From this and other information wildlife managers can formulate ecologically sound hunting regulations.

TITLE: PARTICIPATION IN ERTS-A PROGRAM

PRINCIPAL INVESTIGATOR:

Joel M. Ojal
Ministry of Natural Resources
P.O. Box 30126
Nairobi, Kenya

TITLE: ERTS-A EXPERIMENT FOR ISRAEL

PRINCIPAL INVESTIGATOR:

Professor Joseph Otterman
Tel Aviv University
Department of Environmental Sciences
Ramat Aviv, Israel

SUMMARY: The multi-spectral TV camera system and the multi-spectral scanner system will be operated over Israel and the imagery analyzed for information in the fields of hydrology, agriculture, forestry and arid regions vegetation, and oceanography. In hydrology, the four-dimensional "color" of the scanner imagery can be of direct use in mapping of soil types. Important benefits are expected from mapping of decrease in reflectivity over areas in the Negev with moisture in the soil, as result of rainfalls or subsurface water. The multispectral scanner imagery, with its very important reflective IR band, will be used to map the extent of agricultural species, with attempts for vigor and health assessment, yield prediction and infestation detection. Primary attention will be given to two important crops; citrus and wheat. Monitoring the growth of young forests from satellite altitudes can prove very helpful in further planning of the afforestation program. The study of desert vegetation is of scientific interest and at the same time has practical application, since it can help land use recommendations and uncover potential sites for planting special "desert crops" such as dat palms. In the field of oceanography, it is proposed to attempt to map the ocean color in the Eastern Mediterranean, and to correlate these maps with reports of catch by fishing fleet. In the field of limnology, the pollution in Lake Kinneret will be investigated. There has been a sharp increase in the nutrient status of its waters and algae blooms frequently develop. Spectral observations might provide a useful method of assessing these changes and also indicate their areal distribution. The method of analysis will be initially by color photo-interpretation, with a planned shift to digital computer techniques.

TITLE: STUDY OF SANTA RIVER BASIN

PRINCIPAL INVESTIGATOR:

Jose C. Pomalaza
Instituto Geofisico Del Peru
701 Arequipa Ave.
Lima, Peru

TITLE: ZANDE LAND USE

PRINCIPAL INVESTIGATOR:

Dr. Conrad Reining
Dept. of Anthropology
Catholic University of America
Washington, D.C. 20017

TITLE: VENEZUELA DEVELOPMENT OF TECHNIQUES TO INVESTIGATE AND ESTIMATE NATURAL RESOURCES IN REMOTE AREAS

PRINCIPAL INVESTIGATOR:

Dr. Adolfo C. Romero
Direccion De Cariografia Nac.
Edf. Camejo
Centro Simon Bolivar
Caracas - 101 - Venezuela

TITLE: STUDY OF RECREATIONAL LAND USE AND OPEN SPACE

PRINCIPAL INVESTIGATOR:

Mr. Irvin J. Sattinger
Environmental Research Institute of Michigan
P.O. Box 618
Ann Arbor, Michigan 48107

CO-INVESTIGATOR:

Mr. George N. Skrubb, Director
Oakland County Planning Commission
1200 N. Telegraph Road
Pontiac, Michigan 48053

SUMMARY: The objective of this investigation is to use and evaluate ERTS data in continuing studies of land use in the seven-county area surrounding Detroit, with special emphasis on identifying and evaluating land that should be acquired and preserved for open space and recreational use and to maintain the environmental quality of the area. A major portion of the study will be concentrated on test sites in Oakland County, which is characterized by the presence of a number of lakes as well as wetland and wooded areas. Although the development of methods of land inventory and evaluation will be concentrated on sites of limited size, it is expected that the ultimate use of ERTS data will be directed toward studies of regional scope. Major emphasis will be placed on processing ERTS-1 multispectral scannner imagery to observe and map a number of fundamental factors which determine the suitability of land for recreational land use or open space. Photographic and scanner imagery from aircraft flights, ground truth, and other data sources will be used to supplement and evaluate the ERTS imagery. The MSS data will be processed to map gross categories of land use, note trends in land use, delineate urban boundaries, identify and assess vegetative cover, map bodies of water, observe major shoreline and underwater features, map drainage patterns, and detect sources and types of water pollution.

TITLE: THE COMPARATIVE EVALUATION OF ERTS-A IMAG IMAGERY FOR RESOURCE INVENTORY IN LAND-USE PLANNING AND COMMUNITY DEVELOPMENT

PRINCIPAL INVESTIGATOR:

Dr. G. H. Simonson
Soil Science Department
Oregon State University
Corvallis, Oregon 97331

SUMMARY: This investigation is concerned with the development and presentation of earth resources information for support of land use planning, zoning, and community development programs where the long-term objective is to improve man's relationship to his environment. The central hypothesis is that ERTS or extremely small-scale aircraft imagery providing multispectral and multidate coverage should have important advantages over conventional methods for acquiring and presenting the necessary information for these purposes.

An integrated resource and land use inventory and analysis of pilot counties in central and western Oregon will be made by an interdisciplinary team, including Forestry, Range, Geology, and Soil specialists, using space and highflight imagery with supporting ground truth data. The uses and methods of presentation of these data and maps will be evaluated for multiple resource developeent, land use planning, and monitoring resources and land use. The evaluation process is in cooperation with local planners and other ultimate user groups through an extension-education effort to insure the most effective application of the data in user programs for resolution of their problems. Visual photo interpretation and color enhancement will be used for image analysis. Identification of spectral signatures and automatic pattern recognition techniques will be tested in selected areas.

TITLE: LAND MANAGEMENT IN MINNESOTA

PRINCIPAL INVESTIGATOR:

Joseph E. Sizer
Minn. State Planning Agency
802 Capitol Square Bldg.
St. Paul, Minnesota 55101

TITLE: MULTIDISCIPLINARY STUDY

PRINCIPAL INVESTIGATOR:

Olav M. Skulberg
Royal Nor. Council-Sci. and Ind. RS
Norwegian Inst. for Water Res.
Gaustadalleen 25, Blimderm
Oslo 3, Norway

TITLE: ERTS IMAGE DATA COMPRESSION TECHNIQUE EVALUATION

PRINCIPAL INVESTIGATOR:

Dr. J. Donald Spencer
TRW Systems Group
One Space Park
Redondo Beach, California 90278

TITLE: DEVELOP AUTOMATIC METHODS TO INTERPRET SPACE AND A/C IMAGERY FOR VEGETATION ANALYSIS

PRINCIPAL INVESTIGATOR:

George D. Swanlund
Honeywell, Inc.
2345 Walnut Street
St. Paul, Minn. 55113

TITLE: AUTOMATIC PHOTOINTERPRETATION FOR LAND USE MANAGEMENT IN MINNESOTA

PRINCIPAL INVESTIGATOR:

George D. Swanlund
Honeywell, Inc.
2345 Walnut St.
St. Paul, Minn. 55113

TITLE: RELEVANCE OF ERTS TO THE STATE OF OHIO (MMC NO. 87)

PRINCIPAL INVESTIGATOR:

Dr. David C. Sweet
Ohio Department of Economic and Community Development
65 South Front Street
Columbus, Ohio 43215

SUMMARY: The objective of this experiment is to determine how state government can benefit from orbital surveys such as ERTS. The program is multidisciplinary and involves the evaluation of ERTS imagery and data-relay capabilities to environmental quality, agricultural and forestry, and geographic (land-use) applications in Ohio. ERTS photographic data will be analyzed in combination with aircraft and ground-truth data (photographic and radiometric) collected for five Ohio study sites (Ottawa-Crane Creek Wetlands, Cleveland/Lake Erie, Ohio Agricultural Research and Development Center in Wooster, Zaleski State Forest, and East Liberty Transportation Research Center). Participation in the ERTS DCS experiment is somewhat secondary and involves utilization of a single data collection platform for demonstration of potential use of satellite relays in state environmental quality monitoring networks. The complete program involves the cooperation of the state Departments of Natural Resources, Health, Public Works, Economic and Community Development, Highways, and the Environmental Protection Agency. Prime technical subcontractor is the Battelle Memorial Institute's Columbus Laboratories.

TITLE: EVALUATION OF DIGITAL CORRECTION TECHNIQUES FOR ERTS IMAGES

PRINCIPAL INVESTIGATOR:

John E. Taber
TRW Systems Group
1 Space Park
Redondo Beach, California 90278

TITLE: A DEMONSTRATION EXPERIMENT IN THE APPLICATION OF ERTS-A DATA TO INTEGRATED STATE PLANNING IN THE STATE OF MARYLAND

PRINCIPAL INVESTIGATOR:

Mr. Edwin L. Thomas
Maryland Department of State Planning
301 West Preston Street
Baltimore, Maryland 21201

SUMMARY: This is a "demonstration experiment" designed to evaluate the applicability of ERT-A data to integrated State planning. Integrated planning demands data which show broad baseline patterns and identifies patterns of change. Timely updating of these data makes dynamic planning possible. It is also important to be able to integrate over particular geographic areas data on a wide variety of natural or cultural phenomena so that State planning can simultaneously address the different intersections raised in considering multiple planning issues. The Department of State planning has initiated work on a Generalized State Land Use Plan. The Department will apply both the high altitude and satellite imagery to this effort, testing the applicability with specific emphasis on land use inventories and determining the natural capabilities and suitabilities of the natural resource base to support various uses. The analysis will employ both MSS and RBV data, and the results are expected to be applicable to general State planning practices.

TITLE: ERTS DATA ANALYSIS OF RHONE DELTA

PRINCIPAL INVESTIGATOR:

Dr. Jean-Claude Thomas
Geography Dept.
Catholic University
Washington, D.C. 20017

TITLE: COMPREHENSIVE STUDY OF LEON-QUERETARO AREA

PRINCIPAL INVESTIGATOR:

Jorge F. Hinojosa Vaca
Bureau of Economic Studies
Study Comm. of Nat'l. Terr.
Photointerpretation Div.
Mexico, D.F., Mexico

TITLE: A PROPOSAL TO PARTICIPATE IN ERT-S A FLIGHT INVESTIGATIONS

PRINCIPAL INVESTIGATOR:

Dr. John C. Wilson
Kennecott Exploration, Inc.
Geologic Research Division
2300 West 1700 South
Salt Lake City, Utah 84104

TITLE: CORRELATE IN SITV REFLECTANCE SPECTRA WITH AGRI. LAND USE DATA AND CORRELATE BOTH WITH SPACE ACQUIRED IMAGERY

PRINCIPAL INVESTIGATOR:

Dr. Edward Yost
Science Eng'g. Research Group
C.W. Post Center
Long Island University
Greenvale, N.Y. 11548

TITLE: EVALUATION OF SUITABILITY OF ERTS DATA FOR THE INVESTIGATOR"S REQUIREMENTS

PRINCIPAL INVESTIGATOR:

Walter Zubrycky
Dept. of Fisheries and Forestry
No. 8 Temporary Building
Carling Avenue
Ottawa, Canada

## VII. METEOROLOGY

TITLE: METOROLOGICAL UTILITY OF HIGH RESOLUTION MULTI-SPECTRAL DATA

PRINCIPAL INVESTIGATOR:

John M. Danko
RCA Astro-Electronics Division
P.O. Box 800
Princeton, N.J. 08540

TITLE: THE INTERDEPENDENCE OF LAKE ICE AND CLIMATE IN CENTRAL NORTH AMERICA (MMC # 113)

PRINCIPAL INVESTIGATOR:

Dr. Allan J. Jelacic
Wolf Research and Development Corporation
6801 Kenilworth Avenue
Riverdale, Maryland 20840

SUMMARY: The primary observational objective of this study is to map the temporal variations of the lake freeze/thaw transition zone. Due to the migratory nature of the zone, the test site encompasses most of mid-continent North America from 40°N to 70°N latitude. Within this site approximately 150 moderate-sized lakes, whose morphometry and freeze/thaw history are known, have been designated for intensive study. Sequential ERTS imagery will be used to estimate freeze/thaw dates for each study lake, as well as chart the position of the zone. Such information enables the overall mean depth of lakes in a large area to be estimated. After due allowance for morphometric effects, predicted freeze/thaw dates, such as those obtained by the running mean air temperature calculation, can be compared with observed freeze/thaw dates. On a regional scale, averaged climatic data will be correlated with advances and retreats of the transition zone. Air mass analysis will determine if the transition zone acts as a barrier to the movement of continental polar fronts. This portion of the investigation should help to determine the influence of moderate to large sized continental lakes on regional climate.

TITLE: A SEVERE ENVIRONMENT TEST OF THE ERTS-A DATA COLLECTION SYSTEM (DCS) TO PROVIDE HYDROMETEOROLOGIC INFORMATION IN THE SAN JUAN MOUNTAINS, COLORADO (SR 9642)

PRINCIPAL INVESTIGATOR:

Archie M. Kahan
Bureau of Reclamation
Federal Center, Bldg. 67
Denver, Colorado 80225

SUMMARY: The Colorado River Basin Pilot Project in the San Juan Mountains of southwestern Colorado, a major experiment in the Bureau of Reclamation's Project Skywater, is the proposed site for a rigorous test of the ERTS-A data collection system. The system will be interfaced with an extensive network of telemetered and recording hydrometeorological instrumentation used for monitoring, operating, and evaluating weather conditions for cloud seeding and the increases due to seeding.

The system test will be conducted by the Bureau of Reclamation through contractors already involved with the project. The contractors are: EG&G, Inc.; Western Scientific Services, Inc.; the Geological Survey; and the Soil Conservation Service. Operational transmissions will be taken for two winter-spring seasons, beginning in October and ending in June 1972-73 and 1973-74.

A total of 27 parameters will be transmitted from 7 remote sites, including 15 separate types of data. Data collected from remote installations by ERTS-A will readout at Goddard and transfer to a teletype relay at the National Weather Service at Suitland, Maryland, where it will enter the Bureau's existing Environmental Network linked to a central computer in Denver. The computer can be accessed by Project Skywater users through remote terminals. Estimated time from a remote sensor to central computer is less than 30 minutes.

The experiment will: Determine reliability under severe mountainous conditions; develop processing, operational, and maintenance guidelines; provide cost comparison data; and allow several water resources agencies to gain early experience with the system.

TITLE: THE USE OF ERTS-1 SATELLITE DATA IN GREAT LAKES MESOMETEOROLOGICAL STUDIES

PRINCIPAL INVESTIGATOR:

Dr. Walter A. Lyons
Air Pollution Analysis Laboratory
Energetics Department
College of Engineering & Applied Science
University of Wisconsin-Milwaukee
Milwaukee, Wisconsin 53201

SUMMARY: Aside from occasional photographs taken during manned space flights, ERTS-1 will provide the first high resolution photography of many meteorological phenomena. Atmospheric processes peak on the mesoscale that is, scale lengths of 1 to 100 km. Thus, numerous interesting phenomena cannot be resolved with current operational weather satellites. ERTS-1 photographs will be used in conjunction with several studies in the Great Lakes area. First, extensive field work on the dispersion of smoke plumes from shoreline power plants is proceeding. It is hoped that under certain conditions, ERTS will be able to map the spread of such plumes (for comparison with numerical models and aircraft measurements). Second, an extensive project of cloud mapping is taking place over and around Lake Ontario as part of the International Field Year for the Great Lakes (IFYGL). Included will be the taking of all-sky time lapse photographs from five ground cameras around the lake. The ability of both the ground cameras and conventional satellite data to resolve cloud types, amounts, and geographical distribution, will be tested. Thirdly, several

studies are underway studying the effects of a Great Lakes in supressing convective clouds (summer) or in generating lake snow squalls (winter). ERTS photographs, the first high resolution types to be taken over the Great Lakes, will provide valuable background information. Both ground and aircraft photgraphy will simulate the spectral regions of the RBV cameras to further aid in image evaluation and usefulness.

**TITLE:** **DEPARTMENT OF THE ENVIRONMENT**
**ATMOSPHERIC ENVIRONMENT SERVICE**
**4905 DUFFERIN STREET**
**DOWNSVIEW, ONTARIO, CANADA**

**PRINCIPAL INVESTIGATOR:**

**Mr. R.E. Vockeroth**
**A.E.S. Instrument Division**

**SUMMARY:** **This experiment is concerned with a remote sensing technique feasibility study from ships and ice in Canada's Northern coastal and inland waters as well as a hydrometeorological remote sensing study. The DCP will be used with a number of remote sensors and data acquisition systems during the ERTS experimental period.**

**At present one of our standard Meteorological Data Acquisition or MDA systems has been built and tested with the appropriate sensors. A serial data input DCP interface has been designed and built from the available DCP technical data. We are still awaiting delivery of the DCP.**

TITLE: SURVEY OF THE SEASONAL SNOW COVER OF ALASKA

PRINCIPAL INVESTIGATORS:

Dr. Gunter Weller and Dr. Carl Benson
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

SUMMARY:

The purpose of this experiment is to map snow-cover characteristics in Alaska. Alaska is divided by mountain ranges into three distinct climatic regions. The wet maritime climate south of the Coastal Ranges is sharply separated from the extreme continental climate of the interior, which is in turn separated by the Brooks Range, from the Arctic Ocean climate. Climatic differences are very pronounced along any north-south transect across these mountainous barriers. Available snow data generally have low spatial resolution and are not adequate for many applications in research and engineering. The ERTS satellite provides a possibility of mapping snow characteristics in detail. Satellite data will be used to study the annual snow pack along a north-south transect of Alaska, centered on the proposed oil pipeline. The choice of this transect is partly due to the ease of access to ground truth data from established camps along the route. Extrapolation of results to other parts of Alaska may be possible. The regional progression and retreat of seasonal snow will be examined from satellite data which will be correlated with surface climatic and snow depth, density and temperature data. These data will be interpreted in terms of Hydrology and Meteorology.

## VIII. OCEANOGRAPHY

TITLE: DEVELOPMENT OF A METHOD OF BATHYMETRIC STUDIES FROM SATELLITE IMAGERY

PRINCIPAL INVESTIGATOR:

E. Gama de Almeida
Instituto de Pesquisas Espaciais-INPE
Caixa Postal 515- São José dos Campos São Paulo - Brazil

SUMMARY: It is proposed to use orbital imageries of the test site, through ERTS-1, supported by the existent hydrographic survey through the use of the hydrographic ships and conventional aircraft remote sensing techniques, to study closely the bathymetry of the test region. The main features of the test site area, a square area of 100 x 100 nautical miles, at the "Abrolhos" region on the Brazilian coast, are the irregular subsurface topography and the water clearness which allows the light to penetrate through to the bottom. The objectives of the proposed experiment are the following: a) by means of the orbital imagery from the test site area, using light densitrometric measurements related with real depths, apply Trend Surface Analysis Technique in an attempt to develop a method of bathymetric studies for defining shallow water zones dangerous for navigation; b) perform environment statistical studies of the area for one year, in order to obtain a better condition for performing an assembly operation for optimizing the ground truth collection. Repetitive images of the

test site will be collected and the expected results of the experiment will be time information about better conditions, for executing an assembly operation in the test site and a definition of the dangerous zones for navigation. The agencies involved in this experiment are the Brazilian Space Agency (Instituto de Pesquisas Espaciais) and the Brazilian Navy Hydrographic Office (Diretoria de Hidrografia e Navegacão).

TITLE: EVALUATE THE APPLICATION OF ERTS-A DATA FOR DETECTING AND MAPPING SEA ICE (SR NO. 126)

PRINCIPAL INVESTIGATOR:

James C. Barnes
Environmental Research & Technology, Inc.
429 Marrett Road
Lexington, Massachusetts 02173

SUMMARY: The purpose of this investigation is to evaluate the application of imagery from the ERTS-A RBV and MSS sensors for surveillance of sea ice. The objectives are: to determine the spectral interval most suitable for ice survey; to measure the scale and types of ice features that can be detected; and to develop simplified interpretive techniques for differentiating ice from cloud and for mapping ice features. To determine the reliability with which ice boundaries can be located and ice concentrations mapped in comparison with other types of ice measurements, the ERTS imagery will be correlated with standard ice observations, aerial-survey ice charts, and aerial photography. The data are being analyzed for three primary Arctic areas, Baffin Bay, the Beaufort Sea, and the Greenland Sea; winter ice distributions will also be examined for more southern areas, including Hudson Bay, coastal Labrador, and the Gulf of St. Lawrence. The results of this investigation will enable the maximum use of data from ERTS and future spacecraft systems for operational ship routing, compilation of ice charts, and scientific research.

TITLE: ESTUARY AND BARRIER ISLAND STUDY

PRINCIPAL INVESTIGATOR:

Dennis W. Berg
Engr. Development Division
Army Coastal Eng'g. Res. Ctr.
5201 Little Falls Rd., N.W.
Washington, D.C. 20016

TITLE: STUDIES OF SEA ICE IN SPITZBERGEN AREA, FORMATION OF CONVECTION CLOUDS

PRINCIPAL INVESTIGATOR:

Ole H. Bramnes
Norwegian Meteorological Inst.
Oslo, Norway

TITLE: OCEANOGRAPHY PROGRAM

PRINCIPAL INVESTIGATOR:

Riveroll Gustavo Calderon
Lighthouses and Hydrography Bur.
Dept. of the Navy
Mexico, D.F.,Mexico

TITLE: PRINCIPAL SOURCES AND DISPERSAL PATTERNS OF SUSPENDED PARTICULATE MATTER IN NEAR-SHORE SURFACE WATERS OF THE NORTHEAST PACIFIC OCEAN AND THE HAWAIIAN ISLANDS (SR 209)

PRINCIPAL INVESTIGATOR:

Paul R. Carlson
U. S. Geological Survey
Geologic Division
345 Middlefield Road
Menlo Park, California 94025

SUMMARY: The size and character of many of the critical water mass boundaries in the nearshore areas of the northeastern Pacific Ocean are such that they could be effectively imaged from earth orbit by the sensors scheduled to be on the ERTS-A platform. Repetitive small scale ERTS-A imagery could provide the synoptic seasonal coverage that is needed to integrate on a regional basis the existing oceanographic data and to design effectively an expanded water sampling program. Moreover, an overall look at the entire coast from Mexico to southeastern Alaska will allow us to observe significant similarities and differences in the processes, and existing and potential problems in this populous and economically vital area. We propose to look at the entire coastline in reconnaissance fashion in order to study overall nearshore oceanic circulation and to evaluate the influence of gross differences in climate, ecology, and geology on the size, persistance, and behavior of plumes of suspended particulate matter. More detailed observations will be made at eight target areas where we or our colleagues have access to considerable ground and/or water truth.

TITLE: INVESTIGATION OF THE GEOLOGIC, GEOMORPHOLOGIC, AND OCEANOGRAPHIC PROCESSES IN THE VICINITY OF ELBA ISLAND, ITALY (SR 9674)

PRINCIPAL INVESTIGATOR:

*Paul R. Carlson
U. S. Geological Survey
Geologic Division
345 Middlefield Road
Menlo Park, California 94025

SUMMARY: The island of Elba, located between the island of Corsica and the west coast of Italy is at present one of the most important iron mining regions of Europe. During the past years, this exploitation has been extended to the sands of the insular shelf. The main magnetite and hematite deposits on the island are located near the coast; therefore, the many submarine highs located near the island are of great interest because of their economic potential. This area is characterized by shallow waters (10-60 meters); an ideal area, consequently, for studies of under-sea features with the aid of aerial photographs. This sea zone is also characterized by strong currents: the aerial study of these currents could give useful information about dispersal of pollutants and characteristics of bottom sediments.

Primary objectives are: 1) Determine the distribution of the extensive, well-exposed terrace system which contributes sediment to the surrounding island shelf; 2) Delineate submerged terraces and platforms adjacent to the east side of Elba and between Italy and Corsica; 3) Identify the major circulation patterns in the channel area between Elba and Corsica and across the shelf between Elba and the mainland; and 4) Determine the distribution, persistence, and behavior of concentrations of suspended sediment plumes at the mouths of rivers and streams emptying into the Tyrrhenian Sea near Elba.

*Co-Investigator with two Italian scientists: the Principal Investigator, Attilio Moretti, and Gian Lupo del Bono, of the Servizio Geologico d'Italia

TITLE: RELATING THE CHLOROPHYLL AND SUSPENDED SEDIMENT CONTENT IN THE WATERS OF CHESAPEAKE BAY TO ERTS-1 IMAGERY

ACTING PRINCIPAL INVESTIGATOR:

Dr. Peter Fleischer
Institute of Oceanography
Old Dominion University
Norfolk, Virginia 23508

SUMMARY: The purpose of this project is to correlate ERTS-1 MSS images of estuarine waters with surface measurements. Parameters which can be correlated with satellite imagery will be plotted on a seasonal, thematic basis. These correlations will lead to the development of techniques applicable to the interpretation of coastal-zone remote-sensor data without the need for ground-truth measurements.

Primarily chlorophyll, suspended sediments and turbidity will be measured at predetermined sites and transects in the lower Chesapeake Bay and James River. Bathymetry, salinity, and temperature will also be recorded. Chlorophyll and suspended sediment sampling will be done from a helicopter for synchronization with satellite passes. Turbidity will be measured with a continuous-recording transmissometer which will be towed by the Old Dominion University research vessel LINWOOD HOLTON. Computer analysis of the MSS data will be performed at NASA-Langley Research Center, and will include extraction of the surface transects from the images and MSS-surface data correlations.

TITLE: OIL SLICK DETECTION
STUDY OF POLLUTANTS (MMC # 009-2)

PRINCIPAL INVESTIGATOR:

Dr. A. Fontanel
Geophysics Department
Institut Français du Pétrole
92 - Rueil-Malmaison, France.

SUMMARY: This experiment is concerned with the detection and study of the pollution in coastal lakes and in the western part of the Mediterranean Sea. A great many industries and refineries have been built along this coast and contribute to the polluting of either coastal lakes or the sea. This area also includes large petroleum harbor facilities. On two test sites, various products will be dumped into the sea, underneath E.R.T.S. orbits. Our aim is to detect these various products at the same time with E.R.T.S. and with aircraft equipped with the following sensors : 32 GHz diffractometer, 8-12 micron and 3-5 micron scanners, T.V. camera, color and false color cameras. Then, if possible, after samples have been taken, a chemical analysis of the different samples will be performed. These experiments will be made in cooperation with Centre National d'Etudes des Océans (CNEXO), C.E.P.E. and C.E.R.H. University laboratories.

TITLE: STUDY OF NORTH SEA

PRINCIPAL INVESTIGATOR:

Prof. J. Gullentops
Inst. Voor Aardwetenschappen
Dept. Geomorphology
Redingstraat 16 Bis
3000 Leuven, Belgium

TITLE: DYNAMIC BEHAVIOR OF COASTAL SEDIMENTATION IN THE LIONS GULF

PRINCIPAL INVESTIGATOR:

Prof. Max Guy
Institut Francais Du Petrole
4, Avenue De Bois Preau
92 -Rueil-Malmaison, France

TITLE: APPLICABILITY OF ERTS FOR SURVEYING ANTARCTIC ICEBERG RESOURCES (MMC # 059)

PRINCIPAL INVESTIGATOR:

Dr. John L. Hult
The Rand Corporation
1700 Main Street
Santa Monica, California 90406

SUMMARY: This investigation is associated with a National Science Foundation Grant for "A Feasibility Study of Polar Ice as a Fresh Water Resource". The objectives are: to confirm the adequacy of applicable iceberg resources in the Antarctic by obtaining an inventory count of number as a function of size in the range of horizontal dimensions greater than approximately one kilometer, and to establish the potential operational utility of ERTS for locating and selecting desirable icebergs for their efficient harvesting. The investigation is exploratory to determine the types of ERTS image data that would be most useful under the lighting and background conditions that will apply. The exploratory sampling only includes part of West Antarctica from the Antarctic peninsula to the Ross Sea.

TITLE: STUDY OF THE MARINE ENVIRONMENT OF THE NORTHERN GULF OF CALIFORNIA

PRINCIPAL INVESTIGATOR:

Dr. J. R. Hendrickson
University of Arizona
Department of Biological Sciences
Tucson, Arizona 85721

SUMMARY: The northern Gulf of California including the Colorado River delta, is an important geographical area; not only does it uspport a number of economically important fisheries, but it is currently being considered as the site of a nuclear desalination plant and is a focal point is to establish baseline information for the interpretation of high altitude and ERTS-1 satellite imagery with emphasis on quantification of seasonal variation for the purpose of evaluating the feasibility of monitoring the northern Gulf of California environment by means of satellite or high altitude remote sensing techniques. The test site is bounded by the east and west coastlines of the Gulf of California between 31° and 32° latitude. Data from four sources -- monthly oceanographic stations, remote data collection buoys, six aircraft overflights, and ERTS-1 imagery and digital data -- will be compared and correlated. As an ancillary objective, new information resultant from this investigation will be applied to current Mexican fisheries problems and analysis of environmental phenomena associated with recent decreases in Colorado River flow quantity and quality. The project is in cooperation with the Universidad de Sonora, Universidad Autonoma de Baja California, and Universidad Nacional de Mexico.

TITLE: COMPLEMENT SYNOPTIC OCEANOGRAPHIC DATA GATHERED BY VESSELS AND A/C IN EASTERN SOUTH PACIFIC

PRINCIPAL INVESTIGATOR:

Hector Inostroza
Instituto Hidrografico
De La Armada
Casilla 324
Valparaiso, Chile

TITLE: DEVELOP IMPROVED TECHNIQUES FOR ACCURATE PREDICTION OF OCEAN CURRENTS

PRINCIPAL INVESTIGATOR:

Robert Kee
Development Engineering Division
U.S. Naval Oceanographic Office
Washington, D.C. 20390

TITLE: USE OF ERTS-A DATA FOR MENHADEN FISH RESOURCE ASSESSMENT AND PREDICTION

PRINCIPAL INVESTIGATOR:

Dr. P. M. Maughan
Earth Satellite Corporation
1771 N Street, N. W.
Washington, D. C. 20036

SUMMARY: The U. S. menhaden fishery is the largest volume fishery in the United States. Harvesting of fish is accomplished by spotter pilots observing fish schools directly or certain phenomena associated with the occurrence of schooling fish. Two of these phenomena, turbidity and color, can also be observed from aircraft and satellite altitudes. This experiment is concerned with correlating color variances observed from ERTS-1 with those quantitatively observed at the surface taken from observers aboard commercial fishing boats and aircraft taken from observations from NASA aircraft. The test site is centered in Mississippi Sound, an area where high volumes of menhaden fish are usually taken during the fishing season between April and October. Results are expected to provide correlations between quantitative measurements of color and turbidity with the location and distribution of commercial menhaden stocks.

TITLE: UTILIZATION AND APPLICATION OF MARINE STATION DATA TO THE STUDY OF PRODUCTIVITY ALONG THE EASTERN COASTAL WATERS OF THE UNITED STATES

PRINCIPAL INVESTIGATOR:

Dr. Harold G. Marshall
Department of Biology
Old Dominion University
Norfolk, Virginia 23508

SUMMARY: For the past several years the principal investigator has been conducting studies of marine phytoplankton populations off the eastern coast of the United States between Florida and Maine. On-going collections of water samples are presently continuing from ships over the continental shelf. Samples taken at sea include those for phytoplankton (quantitative and qualitative values), chlorophyll concentrations, temperature, salinity, oxygen, and a variety of nutrients. These sea truth collections and data offer an excellent base for comparison with spectral signatures from the ERTS-A sensor. The sea truth information will provide known chlorophyll values and phytoplankton biomass for over 100 stations over the continental shelf. The satellite data will offer a synoptic coverage of this coastal area where correlations may be made between the spectral bands and the biomass or other ecological data. Projection of determined values of productivity is planned beyond the station sites to other areas within spectral coverage.

TITLE: REMOTE SENSING OF OCEAN CURRENTS IN THE ABSENCE OF SEA SURFACE TEMPERATURE GRADIENTS (MMC # 108)

PRINCIPAL INVESTIGATOR:

George A. Maul
N.O.A.A.
A.O.M.L.
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Miami, Florida 33149

Baroclinicity in major ocean currents causes a surface manifestation of the juxaposed water masses. Each side of the boundary is usually characterized by different temperature, salinity, velocity, sea state and biological productivity (hence color). Insolation in subtropical summers causes the ocean's surface to become isothermal which prohibits the remote detection of the boundary layer by infrared techniques. Ocean color however can be expected to be a year-round locator of the current. The field experiment is in the eastern Gulf of Mexico where the Gulf Stream system forms an anticyclonic flow called the Loop Current. Cruises every 36 days were initiated in August 1972 to collect the basic data for ocean reflectance and to obtain a time-series of the current's geographical position. The ERTS MSS data are being analyzed and cross correlated with ship data in an attempt to locate the deep warm waters of the Loop Current which can be a significant source of thermal energy in this hurricane fertile region.

TITLE: ACQUISITION AND ANALYSIS OF COASTAL GROUND-TRUTH DATA FOR CORRELATION WITH ERTS-1 IMAGERY

PRINCIPAL INVESTIGATOR:

Dr. R. C. Miller
Oceanographic Services, Inc.
Santa Barbara, California 93101

SUMMARY: This experiment is concerned with the correlation of chemical and biological physical ground truth information with ERTS imagery. Test sites have been selected in Santa Monica Bay, Santa Barbara Channel, and Monterey Bay, California. At each of these sites, oceanographic data will be acquired simultaneously with ERTS-1 coverage.

Water color variations in these coastal zones will be correlated with ground truth information including bathymetry, water clarity, water color, extinction coefficient, degree and type of suspensoid matter, bottom sediments, bottom uniformity, surface temperature, and marine meteorological condition.

Precision images from RBV on board ERTS-1 will be subjected to high resolution vidicon and density slicing. Resulting contours of water color will then be correlated with acetate maps of ground truth information. Correlation matrices developed from this procedure will be used as possible algorithms for prediction of oceanographic parameters.

TITLE: THE SURFACE CIRCULATION OF PRINCE WILLIAM SOUND, ALASKA (MMC # 110-09)

PRINCIPAL INVESTIGATOR:

Dr. Robin D. Muench
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

SUMMARY: The purpose of this experiment is two-fold. It is intended primarily as a feasibility study to determine whether visible wavelength satellite imagery is useable for detecting surface circulation patterns in inshore waters. The secondary purpose of the experiment is to estimate surface circulation patterns in Prince William Sound, Alaska. This test area is located along the southern Alaska coast and is the site of intense recreational, commercial fishing and industrial development. Water color and silt plumes from terrestrial sources are to be used as indicators. Ground truth measurements will be obtained from oceanographic vessels in the form of water color and transparency measurements, plankton samples as they affect color, visual estimates of silt content, temperatures and salinities. Water mass analyses will be used to estimate circulation patterns from the ground truth temperature and salinity data; these patterns will then be compared with spectral signatures from the RBV cameras. Results of the study, used in conjunction with results from other concurrent studies, are expected to aid in orderly development of the Prince William Sound region as well as determining the feasibility of such methods of study.

TITLE: DEMONSTRAITING APPLICABILITY OF SATELLITE DATA TO HYDROLOGY AND ICE SURVEY

PRINCIPAL INVESTIGATOR:

DR. ERKKI PALOSUO
INSTITUTE OF MARINE RESEARCH
00141 HELSINKI 14, FINLAND

SUMMARY: This project aims at the study of a single satellite picture the consistency of an ice field in the northernmost Baltic (ice and open water, amount of pressure ridges etc.). If repetitive satellite coverage can be received the changes in the photographs indicate moving of ice, formation of pressure ridges, cracking of ice, melting of snow etc. All these progress of events will be controlled by local investigations.

TITLE: CALIFORNIA COAST NEARSHORE PROCESSES STUDY

PRINCIPAL INVESTIGATOR:

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Ocean Engineer
San Francisco District
Corps of Engineers
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San Francisco, California 94102
(415) 556-5371

SUMMARY: Multiple elements under the broad topic of nearshore processes will be studied with airborne and spaceborne sensor data coincident with sea truth. These elements include (1) nearshore currents, (2) estuarine flushing, (3) season river discharges, and (4) nearshore sediment dispersion. These processes will be studied primarily along the central and southern California coast. Sophisticated data processing techniques will be utilized to obtain the maximum information from available data, and to provide correlation and comparison when possible.

TITLE: USE OF SPACE-ACQUIRED IMAGERY FOR THE MEASUREMENT OF WATER DEPTH

PRINCIPAL INVESTIGATOR:

Fabian C. Polcyn
Environmental Research Institute of Michigan
P.O. Box 618
Ann Arbor, Michigan 48107

SUMMARY: The objective of this investigation is to demonstrate the feasibility of using remote sensing from satellites for making rapid surveys of near-shore environments or other regions about which knowledge of water depth is needed. Two methods for depth measurements will be used:
(1) Measuring wave reflection effects in the Fourier transform domain produced by an optical processor, with a space photograph used as the input transparency. This technique lends itself to use from any altitude, including those of earth satellites, and is independent of the light transmission characteristics of water.
(2) Using multispectral scanner imagery for measuring the relative intensities of lifht reflected at different spectral intervals by the ocean or lake bottom and correcting for surface reflection and scattering.
The ultimate objective of this work is to develop an integrated system, using satellites, aircraft, and surface-based measurements, for detecting and locating shoal areas, and more particularly for measuring water depth. This system can be used to reduce hazards to ship navigation, to aid marine engineering projects, to study shore erosion, to permit assessment of storm-induced changes, and to aid in investigation of lake level and estuarine problems.

TITLE: PROPOSAL FOR OCEAN WATER COLOR ASSESSMENT FROM ERTS-A RBV AND MSS IMAGERY

PRINCIPAL INVESTIGATOR:

Donald S. Ross
International Imaging Systems
510 Logue Avenue
Mountain View, Calif. 94022

TITLE: ESTUARINE AND COASTAL WATER DYNAMICS CONTROLLING SEDIMENT MOVEMENT AND PLUME DEVELOPMENT IN LONG ISLAND SOUND (SR 342-5)

PRINCIPAL INVESTIGATOR:

Fred H. Ruggles, Jr.
U. S. Geological Survey
Water Resources Division
P. O. Bldg., Rm. 235
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Hartford, Connecticut 06101

SUMMARY: It is the purpose of this study to correlate the hydro-dynamics of estuarine and coastal waters with sediment movements and plume development in Long Island Sound. ERTS imagery will be used as a tool to delineate the plume development and litoral sediment transport. In connection with this investigation, tidal discharge is being computed in the Connecticut River Estuary and tidal measurements are being planned in other major estuaries entering Long Island Sound. Stage data are being collected at several locations on the Sound and a mathematical model (due to be completed in October 1972), describing circulation and flow of the Sound, is being developed by the National Ocean Survey (NOS). Background sediment data is being collected by the University of Connecticut and the U. S. Geological Survey, and are being analyzed and correlated with NASA overflights that were flown at altitudes 15,000 and 25,000 ft.

TITLE: INVESTIGATIONS USING DATA FROM ERTS-A TO DEVELOP AND IMPLEMENT UTILIZATION OF LIVING MARINE RESOURCES (MMC # 240)

PRINCIPAL INVESTIGATOR:

MR. WILLIAM H. STEVENSON
NATIONAL MARINE FISHERIES SERVICE
FISHERIES ENGINEERING LABORATORY
MISSISSIPPI TEST FACILITY
BAY SAINT LOUIS, MISSISSIPPI 39520

SUMMARY: The primary objective of this experiment is to demonstrate and establish the feasibility of utilizing satellite imagery to determine the availability and distribution of the adult Gulf menhaden B. patronus within Mississippi Sound and adjacent waters. Secondary objectives are: 1) determine the effectiveness and reliability of ERTS and aircraft RS data to provide fisheries significant coastal oceanographic information, and 2) ascertain the usefulness of these and other resource data for improving resource harvesting and management. Selected oceanographic, meteorological, and biological parameters are being used as indirect indicators of the resource. The study is being conducted through implementation of four sub-experiments catagorized as Utilization, Living Marine Resources, Oceanographic, and Aerospace. Synoptic sea-truth, fishery sampling and weather data, as well as photo and thermal IR imagery, are being acquired as data inputs, and a computer program has been developed to manipulate

these data according to user requirements. Participants of this cooperative venture include various Federal, state and local government agencies, universities, and commercial groups. The experiment is expected to produce correlations between satellite, aircraft, fisheries, and environmental seatruth data. The resulting information will be used to facilitate development of minimum levels of effort required to obtain data for resource distribution studies, and to provide insight into areas of investigation applicable to RS as a tool for resource assessment and monitoring.

TITLE: EVALUATION OF ERTS DATA FOR CERTAIN OCEANOGRAPHIC USES (NMC #106)

PRINCIPAL INVESTIGATOR:

Dr. A.E. Strong
NOAA Satellite Service
3737 Branch Avenue
Hillcrest Heights, Maryland 20031

SUMMARY: Using ERTS 1 clear-sky multispectral data, water color will be charted to determine whether broadband (1000 Å) multispectral imagery can be utilized to locate and map the extent of distinct water masses. Very high resolution infrared (VHRR) measurements from ITOS-D will also be employed for mapping surface temperature. This information will be useful in deducing major surface circulations, particularly in the Great Lakes. Two Great Lakes will be monitored-Lake Erie and Ontario. In Lake Erie the areas around Buffalo, Cleveland, Toledo, Detroit will be surveyed as potential effluent/water quality sites where coordinated surface data from NOAA-Lake Survey will be necessary. In Lake Ontario the waters in the vicinity of Toronto, Hamilton, Rochester and Niagara represent potential color sites. In the Chesapeake Bay estuary, ITOS-IR will be used to monitor thermal characteristics. Prime color targets are around the Susquehanna River mouth, Baltimore, the Potomac and James Rivers, and the mouth of the estuary itself.

In the late winter and early spring Lake Erie acquires nearly total ice cover and will be studied, cloud cover permitting, for the ice reflectance variations. Particular emphasis will be given to relating reflectance differences at various wavelengths, including infrared, to the discrimination of ice types and concentrations and whether snow or melt water covers the ice. Ice often occurs in the northern reaches of Chesapeake Bay also and will be studied.

TITLE: DYNAMICS OF PLANKTON POPULATIONS IN UNWELLING AREAS

PRINCIPAL INVESTIGATOR:

Dr. Karl-Heinz Szekielda
College of Marine Studies
Robinson Hall
University of Delaware
Newark, Delaware 19711

TITLE: SEA-ICE IN THE SEA OF OKHOTSK AND ITS INFLUENCE ON THE OYASHIO CURRENT (MMC =023)

PRINCIPAL INVESTIGATOR:

Dr. Kantaro Watanabe
Kyoto Gakuen University
Nanjo, Sogabe-cho, Kameoka-shi
Kyoto-fu

SUMMARY: This experiment is aimed to estimate the total volume of sea-ice born in the Sea of Okhotsk and its contribution to the Oyashio current flowing shouthwestward off southern coasts of the southern Kurile Islands and Hokkaido. The total volume of sea-ice is estimated by detecting distributions of types, the closeness and the surface roughness of sea-ice with multispectral photograghs by ERTS, and by measuring sea-ice boundaries with ESSA's AVCS pictures or ITOS-D's SR data. For finding the relation-ship between images of ERTS multispectral picture and the surface roughness of sea-ice, will be used together aerial photographs and radar imageries of ice-field off Hokkaido. The result on the total volume of sea-ice leads to an estimation of its contribution to the Oyashio Current using data on water-color distribution detected from multispectral photograhs of ERTS together with oceanographic data from ships.

TITLE: SEA ICE AND SURFACE WATER CIRCULATION, ALASKAN CONTINENTAL SHELF

PRINCIPAL INVESTIGATOR:

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Extension Oceanographer
Sea Grant Program
University of Alaska
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SUMMARY: Sea surface circulation over continental shelves is important to the study of high latitude oceanography. In particular, movements of the surface water influence profoundly the distribution of terrestrial sediments and sea mammals. The surface circulation is a complex function of the instantaneous climatic regime, and overall, seasonal meteorologic and physical influences. Large-scale circulation can be monitored readily from satellite observations in the Alaskan region because of two seasonal factors. In the winter the sea ice cover of shelf waters is not continuous; it is a complex of pressure ridges and open leads which should be clear to ERTS-A imagery. The persistence of these leads is critical to the ecology of seals and polar bears and effectively controls their distribution over more than half the year. During the summer, many rivers are very heavily laden with silt and finer debris. This turbid water often travels considerable distances at the sea surface, thanks to slow mixing with the more dense sea water beneath. From ice and turbid water distribution, the surface circulation patterns will be studied in three specific areas around the Alaska coast: Cook Inlet, Bristol Bay, and around the Bering Straits. Techniques evolved for this study should be useful in satellite studies of other more remote high latitude areas.

TITLE: AN INTERDISCIPLINARY STUDY OF THE ESTUARINE AND COASTAL OCEANOGRAPHY OF BLOCK ISLAND SOUND AND ADJACENT NEW YORK COASTAL WATERS (MMC # 070)

PRINCIPAL INVESTIGATOR:

Dr. Edward Yost
Science Engineering Research Group
Long Island University
C.W. Post Center
Greenvale, New York 11548

SUMMARY: An interdisciplinary study of the physical, chemical, and biological relationships of Block Island Sound and New York Bight coastal waters is being conducted using shipboard sampling techniques. Preliminary studies have indicated the presence of unexpected large color differences which are believed to be related to circulation and water mass characteristics, nutrients, trace metal, and the organic content of the water, as well as to the quantity of phytoplankton present. Using ERTS-A RBV and MSS imagery, additive color analysis will be conducted employing multispectral viewers and correlated with the in situ spectra and water sample data. Density slicing, isoluminous and isophote analysis will also be performed to achieve the maximum information regarding the spatial location and probable composition of the water masses in order to present a coherent thermatic display on hydrographic charts. The results are expected to be applicable to ecological impact of the spatial and temporal changes of coastal water masses on the New York environment in the near term.

## IX. SENSOR TECHNOLOGY

TITLE: PERFORMANCE OF THE ERTS DATA COLLECTION SYSTEM IN A TOTAL SYSTEM CONTEXT (SR 210)

PRINCIPAL INVESTIGATOR:

James F. Daniel
U. S. Geological Survey
Water Resources Division
2222 Schuetz Road
St. Louis, Missouri 63141

SUMMARY: This investigation is intended to put the finishing touches on a complete and intensive test of the ERTS DCS. Individual experimenters will conduct the field tests and report successes and failures of the DCS to supply correct data. The approach will be to collate the results for all these individual tests with the intention of determining the nationwide performance of the system, and, hopefully, will identify problems with the DCS, whether equipment or method, as being either local, regional, or national in effect. Additionally, possible modifications to the DCS to solve the problems encountered will be identified. The objective of this investigation is very brief and simple. It is, to determine the effectiveness, both in cost and reliability, of the ERTS Data Collection System.

For all Department of Interior DCS investigations as well as any others designated by NASA as willing to cooperate with this principal investigator, the determination of 3 statistics will be made: (1) The number of possible DCP transmissions per satellite pass, based on total time of mutual visibility of DCP, satellite, and receive site; (2) The number of transmissions received at the NDPF; and (3) The number of correct transmissions received, as compared with in situ recorded data, at both the NDPF and by the experimenter. From comparison of these figures, the source or sources of error can be determined and solutions can be found.

TITLE: NAT'L. PROGRAM ON REMOTE SENSORS

PRINCIPAL INVESTIGATOR:

Hector R.M. Higuera
Nat'l. Commission on Outer Spa
CE
Zola Y Ave. Universidad
Mexico 12, D.F., Mexico

TITLE: SURFACE CALIBRATION AND IN SITU DATA ACQUISITION TECHNIQUES DEVELOPMENT USING DATA COLLECTION PLATFORMS - DCP'S (SR # 198)

PRINCIPAL INVESTIGATOR:

Robert L. Krieger, Director
NASA, Wallops Station
Wallops Island, Virginia 23337

SUMMARY: Six DCP emplacements within the Chesapeake Bay have been selected in conjunction with the several requirements of various ERTS-1 Principal Investigator interests in the Bay, to serve as moored sea-truth sites in the Chesapeake and Delaware Canal, on four river sites leading into the Bay, and at the mouth of the Chesapeake Bay. These platform sites will be fully instrumented with sensors which via the ERTS-1 Data Collection System DCS will furnish the following data every 12 hours with 0.95 probability and a message error probability less than 0.1%: Water Temperature, Current Velocity, Current Direction, Dissolved Oxygen, Turbidity, Conductivity, Wind Speed, Wave Height, Wave Period, Tide Height and pH Factor. In conducting these experiments it is hoped to demonstrate the effectiveness of this class of sensor technology as an aid in image interpretation wherein the goals of the scientific investigators relate to remote sensing of turbidity, pollution and marine productivity. In conjuction with these investigations Wallops Station aircraft will be available to overfly those areas of the Bay which have been determined to be of interest from the results of ERTS-1 imagery analysis. Since the satellite has an 18 day interval between overpasses of the Bay this aircraft support to regional investigators will maintain a continuity of observations to assist in tracking and recording progress of observed waterborne phenomena of interest between successive satellite overpasses.

TITLE: DATA RETRANSMISSION VIA SATELLITE

PRINCIPAL INVESTIGATOR:

Mr. H. W. MacPhail
Canada Centre for Inland Waters
Burlington, Ontario

SUMMARY: The present objective is to acquire technical capabilities in this field and to assess the quality of data using retransmission methods. The long range objective is to apply this technical capability to future data collection systems, likely from remote or mid-lake regions. The future data requirements could cover any of the scientific fields involved in lake research (such as water quality monitoring). The present test site is near the Niagara River in Lake Ontario. The parameters being measured are near surface water temperature, air temperature and relative humidity.

TITLE: INVESTIGATION OF TECHNIQUES FOR CORRECTING ERTS DATA FOR SOLAR AND ATMOSPHERIC EFFECTS

PRINCIPAL INVESTIGATOR:

Dr. Robert H. Rogers
Bendix Aerospace Systems Division
The Bendix Corporation
Ann Arbor, Michigan 48107

SUMMARY: This experiment is concerned with evaluating the capabilities of a wide range of candidate techniques for determining and removing solar and atmospheric parameters and effects from ERTS data. The purpose is to obtain absolute target reflectance signatures. Techniques to be evaluated will include transferring known ground reflectance to spacecraft measurements, the use of ground-based Radiant Power Measuring Instruments to measure directly the needed solar and atmospheric parameters, radiation transfer models, and the use of spacecraft data without auxiliary inputs. ERTS MSS Computer Compatible Tapes (CCT) will be transformed into reflectance, using factors derived from these calibration techniques, and the computed reflectance compared with that from ground truth. Reflectance of the truth sites, located near Traverse City, Michigan, will be obtained from ground-based spot sampling with hand-held Radiant Power Measuring Instruments and from MSS data gathered by aircraft. Results will include a knowledge of the accuracy achievable by various calibration techniques, specifications for Radiant Power Measuring Instruments optimized for ERTS that permit direct measurement of atmospheric parameters and truth site reflectance, and computer techniques for correcting ERTS CCTs for atmospheric effects.

TITLE: EVALUATION OF ERTS-A IMAGE SENSOR SPATIAL RESOLUTION IN PHOTOGRAPHIC FORM

PRINCIPAL INVESTIGATOR:

Dr. P. N. Slater
Optical Sciences Center
University of Arizona
Tucson, Arizona 85721

SUMMARY: This investigation determines the in-flight imaging performance of each band of the ERTS-A RBV and MSS multispectral sensors. The availability of simultaneous underflight photography from aircraft allows the use of the following method. Spatial frequency spectra of the spacecraft and simultaneous underflight aircraft imagery are calculated from microdensitometer scans of the same ground area on each set of imagery. Transfer function measurements at very low spatial frequencies and spectroradiometric calibration of the aircraft sensors permits determination of the object (ground) radiance spatial spectrum. This is then scaled to the higher spatial frequencies in the spacecraft imagery and used to measure the transfer function of these sensors. Sensor resolution can then be estimated. From this program, the quality of the imagery supplied to users of the data is determined, and requirements on future sensor performance can be outlined.

TITLE: COMPUTER MAPPING OF TERRAIN USING MULTISPECTRAL DATA FROM ERTS-A FOR THE YELLOWSTONE NATIONAL PARK TEST SITE (SR 236)

PRINCIPAL INVESTIGATOR:

Harry W. Smedes
U. S. Geological Survey
Geologic Division
Denver Federal Center
Denver, Colorado 80225

The experiments will compare the accuracy and suitability of the ERTS-A sensors with previous studies of aircraft data in automatic mapping of terrain using both supervised and nonsupervised computer techniques.

In the supervised techniques, training areas of different classes of material are selected on the basis of ground control data. The statistical parameters of radiance from these training areas are used in computer programs of the University of Michigan to recognize and map all other areas of occurrence of those classes.

Preprocessing of data, and image enhancement techniques will be used to increase the accuracy and usefulness of the data, and reduce computer time.

Data will be analyzed at different times of the year in order to determine optimum times for classification of the maximum number of classes. Bedrock detection probably will be optimum in late summer when the snow is gone from the highlands. At that time we plan to determine the number and kinds of rock types that can be discriminated, and the accuracy. At other times of year, we expect to determine optimum times and conditions for detecting various plant assemblages and different surficial deposits (in the lowlands) as a function of their permeability, porosity and, hence, moisture retention.

Atmospheric data from the Cripple Creek-Canon City ERTS test site may be used in preprocessing to minimize the effect the atmosphere has in degrading the spectral signatures and accuracy of mapping of terrain classes.

A lineament map of the entire test site made from study of conventional aerial photographs will be compared with the ERTS-A imagery to see if even larger regional fractures can be discerned.

In the nonsupervised computer programs, the terrain classes are recognized on the basis of the statistical clustering of radiance data in N-dimensional color space (N = 4 for the MSS and 3 for the RBV system). The classes derived by this clustering technique are each mapped by the computer, each being shown by a different symbol. Comparison with ground control data enable these natural classes to be identified. This technique eliminates subjectivity (bias) and calibration problems inherent in the supervised techniques.

The classes mapped previously by computer include bedrock, talus, vegetated bedrock rubble, glacial till meadow, glacial kame meadow, forest, bog, water, and cloud shadow. Deciduous forest was distinguished from coniferous forest and, in the nonsupervised cluster studies, mafic rocks were distinguished from felsic rocks.